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THE CONSTRUCTOR'S PROBLEMS

Charles E. McKee<sup>a</sup>  
(Proc. Paper 1244)

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SYNOPSIS

This paper reviews the roles of the highway administrator, the engineer and the contractor in an expanded highway program. The problems encountered by the contractor in the five M's of management are discussed, as well as the manner in which the engineer and administrator can help minimize many of those problems.

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The enactment of the 1956 Federal Highway Act by the Congress carries assurance for the first time in Highway history, to the public, engineers and contractors, that a sizable highway program will be in progress for a considerable period of years. Both engineers and contractors can now plan their work with confidence in the future. However, if these two groups are to be used effectively, there must be complete understanding between the two parties as to what is required and how it is to be done. If there is this complete understanding, then the work will be carried on efficiently and economically. If there is not this understanding, there will be delays, claims and court actions. Everyone would be the loser under these conditions.

The actual building of the road and turning it over to the public is the climax of all the efforts of the administrators, planners, designers and contractors. True, the administrator passes through so many crises in his planning and design operations, that the actual climax for him, in many cases, is passed before a contract is awarded. Nevertheless, all of his previous efforts are for naught until a properly constructed facility is made available for motor vehicle transportation. Great progress has been made in coordinating the efforts of engineers and contractors by the elimination of many things and conditions which are not fundamental to the production of a quality product. Much credit is due the A.A.S.H.O. for its efforts along these lines.

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a. Ohio Contractors Assn., Columbus, Ohio.

Yet, there still appears to be a wide gap in a proper understanding by the engineers of a contractor's operations and what things tend to delay these operations, make them more costly and generally create problems. This comes about, I believe, because of the radical difference between the engineer's operation and the contractor's. The engineer's work embraces the creation of ideas and placing them on paper, so that they can be translated into a physical product for the use and convenience of the public. The contractor, on the other hand, is involved primarily in physical operations in which he is brought into contact with many forces which are foreign to those encountered in the engineer's normal work. In other words, the engineer must know the "why" and the contractor the "how" of construction.

The construction business, as any other business, is one concerned primarily with management. It is the combining of men, money, materials, machinery and methods to produce a finished product. These are the well-known 5 "M's" of management. It is, in fact, the logistics of assembling a veritable army of men, supplying them with the necessary materials and machinery, and applying the methods necessary to produce completed work efficiently and economically. An examination of these elements may provide a background for a better understanding of the contractor's problems.

### Men

Employment in the construction industry is quite fluid, because it is necessary for the contractor to follow the work which is set up in many widely separated localities, and he is unable to carry a full working force with him from place to place. As a result, his permanent cadre of employees consists of only his key men. The greater part of his working force is hired locally. These local men are skilled in their various trades, but for the most part are unfamiliar with the pattern of operations of the particular job. Nevertheless, they must be welded into an efficient working force in a very short space of time. The average wage of construction workmen is about \$2.76 an hour, with wages of skilled workmen in many areas exceeding \$3.50 an hour. For an overtime operation, therefore, assuming that there is a time and one-half requirement, the average wage exceeds \$4.00 an hour and the average wage of a skilled worker exceeds \$5.00 an hour. It is plainly evident that to keep costs within economical limits, mechanization must be resorted to wherever possible and delays in production processes avoided. This is the reason that contractors have been saying to designers for several years "avoid specifying or designing structures that require a great deal of hand labor."

The prevailing wage provision in the 1956 Federal Highway Act has been the cause of some concern. Your cooperation in two respects is solicited. First, check with your local highway contractors to ascertain what agreements they may have entered into with labor to assure that the true prevailing wages for highway work are certified in your bid proposals. Second, keep the red tape of enforcement to a minimum. Perhaps a simple affidavit from the contractor that he is paying the certified wage rates could suffice, rather than submission of bulky payroll sheets. For, after all, in case of a complaint, the contractor's records are always available in his office for a period of years after the completion of the work.

### Money

Money is an ever-present problem in a contractor's operation, as it is in every business. Men must be paid weekly, discounts must be taken on materials purchased, payments must be made on equipment if it is purchased on time-payment basis, as well as other incidentals of expense.

The money market is "tight", according to all financial reports. Interest rates are rising. The cost of machinery, as well as materials, has increased rapidly during the past few years. These are background facts which administrators of highway construction might consider and afford relief where it is possible to do so.

Payments for work performed should be made promptly and frequently. High retainages, both during and after substantial completion of the work, should be considered as a part of a past age. As a matter of fact, with pre-qualification of bidders, performance bonds, public liability and all forms of insurance coverage, the whole subject of retainage should have a careful screening to assure that the public is not paying for nurturing a sacred cow. Perhaps here is one way administrators can assist in carrying out the intent of Congress, as expressed in Section 116 (d) of the Federal Highway Act of 1956, which states that it is the policy to encourage small business to secure contracts in connection with Federal aid highway improvements.

### Materials

It has long been an established principle in highway construction to utilize local materials whenever they are available. This principle has been very well carried out generally. However, some materials are not available locally, but must be secured through more or less centrally-located manufacturing sources. Many other industries draw on these same supplies. Therefore, in an expanding economy such as ours, it is not unusual to run into shortages such as exist today in steel or in some cases cement. However, if materials are not available, allowance for that fact should be made by the highway administrator both in design and completion dates.

One of the problems facing the highway contractor is the "price escalator" clause used by some suppliers. In other words, a base price is quoted, to which is added an indefinite increase in price at the time of delivery. The contractor, however, must quote a firm price to the contracting agency. He feels, therefore, that efforts should be directed at every level toward the elimination of price escalation. It has been suggested that State highway departments furnish materials which are in short supply. The contractors believe that except for emergency situations the contractor himself should furnish all materials.

Prompt testing of materials is, of course, essential if delays are to be avoided. On this, Ohio has pretty well solved the problem by decentralizing many of its testing operations to its highway district offices. Delays in this respect have been practically eliminated as a result of this policy.

Probably the most common material used in highway construction is soil. Yet, while it is a material about which much has been written, it seems to be one of the most troublesome and the least understood on construction. Soil profiles, furnished with plans for bidding purposes, have been very useful to the contractor. However, care should be exercised that the information

furnished through this media is not misleading. For instance, borings taken in connection with the preparation of the soil profile may show that the soil, when properly dried and manipulated in the laboratory, is suitable for placing in an embankment and it is so specified. Accomplishing this result under field conditions may reduce the production capacity of the contractor to a point where the utilization of the particular soil may be costly beyond reason. While there is an apparent reluctance on the part of engineers to waste even a single yard of dirt, careful interpretation of the soil profile by the designer, taking into consideration field operations, might prove in cases that it is cheaper to waste and borrow than to salvage the dirt which is to be excavated. In fact, it might be well to set up a separate item for excavation and waste.

The borrow pit is another item which could be gainfully explored. On urban work, especially, borrow is difficult to find at a reasonable cost and also costly to transport in trucks over city streets. At least, when borrow is specified, the designer should have knowledge that it is obtainable and is permitted to be hauled over city streets. In rural areas, many times, too restrictive specifications make economical borrow impossible; because, invariably, the specifications state that the borrow pit must be located a certain distance from the right-of-way, while in reality the cheapest borrow is contiguous to or within the right-of-way of the improvement.

Finally, on soils - if you use moisture density specifications for embankments, be sure that the specifications can be met with the soils available. Otherwise, you just wear out the soil with useless manipulation and exhaust the patience of the contractor as well as his pocketbook.

### Machinery

Recent surveys indicate that there is an ample supply of construction machinery except for a few items of special equipment.

The equipment manufacturers have done a wonderful job in producing equipment which is capable of performing the work economically and thus offsetting to a great extent the increase in labor costs. Yet, at times, there appears to be a reluctance on the part of highway engineers to accept the growing size of this equipment, as it is usually of necessity over-size or over-weight. Special permits for its movement must be secured. Engineers are inclined to say "tear it down" or "ship it by some transportation facility other than highways," or "when are they going to stop building such big equipment?". To answer these and other questions which are raised, let's face up to the problem. You, as engineers, have to have it to meet your specified requirements of moving large masses of materials and at the same time keep prices within your limited budgets. The contractor has to have it to remain in a competitive position. In most cases highways are the only transportation facilities over which it can be moved without costly delays and tear-downs. You can help both yourselves and the contractor by working out reasonable rules for making the required moves of machinery quickly and with the least red tape while at the same time insuring the safety of the traveling public and the structural integrity of your highways.

### Methods

Method is the element which ties men, money, materials and machinery into a productive unit. There is no substitute for experience in the

contracting business with accompanying knowledge of the proper methods to use in building a highway facility. Naturally, the contractor should be allowed as much freedom as possible in the selection of the method, so that the full benefit is derived from his ingenuity and experience. Yet, the contractor alone does not determine these methods. The engineer fixes the design, specifies materials and many times methods, and thus, generally, sets up the pattern of the contractor's operations. As I mentioned above in speaking of soils, at times it appears to the contractor that design is based upon results obtainable through laboratory methods rather than methods which are available to the contractor in the field. When this occurs, there is apt to be trouble.

Some standardization and uniformity of design is desirable and it is noteworthy that considerable progress has already been made along this line. However, it is also realized that each highway improvement must be custom-designed to fit a condition existing in a certain locality. Improvements in urban areas usually challenge the ingenuity of both the contractor and the supplier to meet the specific requirement for varied curb and gutter forms, special castings and similar items. I have seen jobs with as many as five different types of pavement included in the one improvement, which required different forms, different materials, different machinery, all of which added up to a costly operation. Most of these changes in type are due to building approach roads or mail box returns. For the amount of yardage involved, it would have been much cheaper to have built the approaches of the same materials as the main road - because the approach sections do not lend themselves to a repetitive operation procedure. Similarly, this non-standardization occurs on pedestal-type piers or abutments of bridges where the designer feels that he is saving money by varying the diameter of the columns an inch at a time. The saving in concrete is more than offset by the additional expense in forming. These savings might be termed penny pinching rather than economical. Generally, the elimination of "frills" which cannot be built through the ordinary mass production methods would result in much saving in both time and money. Some attention to these items would make it much easier for the contractor to build the job and to turn out just as usable a product.

When a job is offered for bids, the contractor should reasonably expect to have available a set of plans, specifications and proposal forms which can be readily assimilated and which are properly coordinated. Here, too frequently, he becomes acquainted with some of the idiosyncrasies of the engineering profession. The specifications may not fit the personal desires of the designer, so he invariably places a note on the plans which modifies the specifications. The plan reviewer, in turn, finds something lacking in the plans and places a modification in the proposal. Each is sincere in proving that by his actions he is aiding in securing a better job, but fails to realize that he is making it quite difficult for the bidder to understand the general intent of the plans and specifications. With some temerity, in this connection, may we suggest that a little "brushing up" on Engineer English might be in order, as an aid in avoiding misunderstandings.

The contractor is also entitled to a plan which is accurate and a design which fits the conditions existing in the field. It has long been said that leg exercise is an essential element in producing a workable set of plans. This is certainly most true on highway work. It is a frustrating and a lost cause

for a contractor during construction operations to have to wait for a change in design or a correction of an error which could have been very well avoided by a few visits to the work site by the designer during the design period. Everyone has read with interest and approbation of the efforts of the engineering profession to get out plans faster and eliminate unnecessary procedures in the preparation. We would like to suggest one note of caution on this point; i.e., be sure that your plans contain all the information necessary to build the job. Short-cut all the mechanical operations that you possibly can, but please do not short the contractor on the information which is necessary for him to have. We all realize there is a critical shortage of engineers, but in passing on to contractors the preparation of supplements to plans for the information of his field forces and other operations which were formerly performed by the engineers of the owner, you simply force the contractor into the engineer market and thereby accentuate your own shortage of engineering help.

Another point to be considered is proper merchandising of work. By this I mean the proper time of year to offer projects for bidding, the capacity of existing contractor-organizations, availability of materials to perform the work and time allowed for bidding purposes. All of these items have been discussed in detail from time to time at various conferences. They are mentioned here again only to emphasize the continuing need for an orderly approach to the markets of contractors and suppliers. This is more necessary with the long-range program ahead, in order to avoid a feast and famine condition.

Coupled with merchandising is the subject of completion dates. With the great need for new highway facilities, everyone is anxious that the new improvement be made available for use at the earliest possible date. This is also desirable from a contractor's viewpoint, for there is nothing that will drag money out of a contractor's pocket faster than unduly prolonging a job.

So, from everyone's viewpoint, reasonable completion dates are highly desirable. On the other hand, unreasonable completion dates cause trouble for everyone. The traveling public is unhappy if the date is not met, the project is costing more than it should because the contractor is forced into overtime operations, which require premium pay for his men. Furthermore, men working under pressure are more prone to have accidents, so that unreasonable deadlines for completion of a project can very well mean "death" lines for the workmen.

The timely acquisition of right-of-way and the moving of utilities are not only problems for highway administrators, but are also of increasing concern to contractors. If at all possible, the site should be cleared prior to the beginning of construction operations. With the big push on to get the new highway program underway, it may seem expedient to offer projects for letting with the right-of-way only partially acquired and a promise that it will be cleared at some future date. Caution should be exercised to assure that these dates can be met; otherwise, you may have the contractor so mixed up in his operations that he is in serious trouble. With more highway work coming on the market in urban areas, the problem of properly locating underground utilities is a serious one. Probably adequate plans and accurate locations of these utilities are not available in all cases. However, it would seem to be cheaper to locate these utilities accurately prior to construction, rather than to have the contractor dig into one and disrupt some vital service to the community.

Finally, one of the most troublesome items affecting a contractor's operation is job supervision. Here, again, there is no substitute for experience. A good construction engineer should know both the "why" of the engineer and the "how" of the contractor. With an expanding highway program there will be many newcomers in the supervisory field who have had no previous experience. Colleges for the most part do not have courses in construction, so that novices are unable to judge what is good construction or what elements are essential to emphasize from a design viewpoint, and as a result there is much loss of time, effort and tempers on unessential details. More experienced engineers in higher echelons of supervision may find themselves overwhelmed with paper work and trouble calls on the telephone. They may be unable to visit the jobs and may gradually lose touch with the actual operations. With this loss will come delays in making decisions which will in turn cause extra moves of the contractor's plant to back up and perform work which he should have been able to do at a more opportune time in his operations. Prior to the beginning of construction a conference between the contractor and the supervisory personnel to discuss the schedule and plan of operations has been found to be helpful. An educational program by the highway departments for supervisory personnel would also shorten a rather formidable gap between our present technical educational courses of college and the experience which is now acquired through a more or less trial-and-error basis at the expense of the contractor.

In conclusion someone said recently that the most crying need is for the engineer to make it easier for a contractor to do his work. I have attempted to point out how this can be done through a better understanding of the five elements of management - men, money, materials, machinery and methods. The job ahead for the highway engineer and the contractor is challenging. But, the horse-and-buggy days of highway construction are gone and we are embarked on a program geared to the present, which we hope will fill the needs of the future. However, if we are to carry on this program in high gear, rather than in second gear, it is high time that in each locality both the engineer and the contractor engage in a more frank exchange of views on a professional basis to enable both to better coordinate their efforts.



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PROBLEMS OF ENGINEERING MANAGEMENT

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(Proc. Paper 1245)

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SYNOPSIS

Engineering management comprises the direction, supervision and co-ordination of the design and construction phases of a highway program and will be a major factor in the successful completion of the national highway program. Through the medium of good engineering management, it will be the responsibility of highway administrators and engineers to assure the timely completion of the various inter-related phases of the program to prevent loss of time, money and traffic service to the public.

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Engineering management comprises the direction, supervision, coordination and approval of all of the detailed engineering work required to produce a major highway project in a minimum of time. A large project can be reduced to a series of smaller projects for the purposes of design and construction, and through proper engineering management, the smaller projects can be controlled and coordinated so that they can be integrated into a single completed project in approximately the same length of time required to produce any one of the smaller projects. In light of the highway program facing the highway engineers of this country, expeditious engineering management becomes imperative so that lost motion and time can be reduced to a minimum.

First and foremost, it is the responsibility of engineering management to clear the roadblocks that frequently impair the prosecution of the work and which lead to the loss of time, money and traffic service.

Consider, for instance, the relatively simple matter of design criteria. Through honest differences of engineering judgment and opinion, it can become necessary to redesign large portions of the work with consequent loss of engineering effort and time. It is incumbent upon engineering management, therefore, to eliminate this possibility of wasted effort and to insure uniformity of design by establishing the design criteria for the project prior to

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the commencement of work on the detailed plans and specifications. Drainage design criteria which vary substantially, depending upon geographic location and topographic conditions, should be developed in detail covering all elements of roadway drainage as well as outside drainage areas. Such elements as selection of type and architectural treatment of structures, interchange ramp geometry, controlling grades, curvatures and sight distance controls, design speeds, roadway appurtenances, and other similar elements should be developed and established by those responsible for engineering management of the project. In addition to the basic design criteria, there must be developed the general criteria and need for such public services as water supply, sewage disposal, telephone and other means of communication as may be required for police patrol and maintenance of the facilities.

Further design controls in the form of general specifications and standard and typical drawings which are applicable to all segments of the project must be developed.

To divert for a moment on this subject of general specifications, in recent years, there has been a decided trend to include more and more unilateral provisions in the general provisions of the specifications. As a consequence, there has been a companion trend on the part of contractors to approach each job from the beginning on the theory that it is mandatory that he must pay particular attention to the building of records solely for the purpose of protecting himself against such provisions. The result is often the complete disruption of the harmony and teamwork between engineer and contractor which is so vitally needed for the completely successful project. It would be worthwhile to take a long look at and review of the general provisions, with the aim toward taking a sound practical view in the construction of these provisions rather than the strictly legalistic approach which has been the tendency.

Another facet of the specifications which has been unsound, is setting forth in the specifications the end result required and then establishing the method by which the end result is, or rather is hoped to be, attained. This procedure divides the responsibility which should lay entirely with the contractor and divided responsibility leads to trouble. It appears completely sound that having determined what the end result should be, the engineer should leave the method of attaining that result solely to the contractor.

Over and above the establishment of design criteria for the project, further controls must be exercised to produce uniformity of engineering work to be performed. This can be accomplished through the development of detailed specifications covering the engineering phases of design and construction. Such specifications cover the manner of producing design and construction control surveys; the method and frequency of soils samples to be taken and the tests to be run; the method of developing soils profiles, the manner in which preliminary designs and plans are to be prepared and submitted for approval; the manner in which utility lines are to be handled; and other similar controls.

During the preparation of design plans and specifications, it is of utmost importance that the engineers responsible for management of the project maintain close liaison with those engineers responsible for the detail design work so that the myriad of problems that arise during the development of any large project can be resolved promptly without loss of time or motion.

The timely acquisition of right-of-way is a major factor in the construction schedule of any large project, and it is a prime function of engineering management to coordinate the preparation of contract plans, the appraisal and acquisition of rights-of-way and the award of construction contracts. Experience has shown that fully 20 per cent of the manpower requirements of engineering management for a large project must be devoted to this particular phase of the work and properly so, recognizing the importance of this element to the over-all success or failure of the project. Improper coordination of acquisition of rights-of-way with planning and construction can and often does result in substantial losses of time, money in the form of claims, and traffic serviceability.

Another major element in the development of a large highway project, is the matter of public utility facilities which are either publicly or privately owned. To permit the orderly preparation of contract plans and the orderly prosecution of construction operations, it is necessary that the manner in which such utility lines are to be handled be ascertained and agreed upon very early in the development of the project. To accomplish this end, the engineers responsible for the direction of the project must confer with the owners of the utilities regarding the crossing, closing or relocation of their public utility facilities and negotiate agreements covering such crossings, closings or relocations. These agreements must cover the manner or code under which the work will be done, the sequence of operations, when work is to commence and be completed, the manner and method of compensating for work performed and insurance requirements, if any.

Companion to, but apart from the required negotiations for adjustment of public utilities, are the negotiations with regard to the crossing or underpassing of railroad lines. Depending upon the type of line to be crossed and the volume of traffic using such lines, resolving of the resulting problems can become complex and difficult. Agreements with the railroads usually entail the establishment of precise methods and times of operation, provisions for the security of the work at all times, establishment of vertical and horizontal clearances, the checking and approving of structural stability during and after construction, and last but certainly not least, the insurance provisions to be included in the agreement. There are instances where costly delays and extensive litigations have resulted from failure to resolve such agreements at the proper time in the development of a project. This is an important function of engineering management.

Then come the negotiations with other levels of government, whether it be state, county, municipal, township, etc., regarding the closing, relocation, or adjustment of other public highways for the purpose of providing grade separation structures, or otherwise accommodating the construction of the proposed facility. This is a very important element with respect to the timing of the project since it falls in the interim between the preliminary design and the final planning of the project. In view of the fact that intersections with other highways are often control points in the determination of final lines and grade, the completion of the planning phase of a facility is dependent upon quick determination and agreement regarding the solution at these locations. Not only is there the problem of traffic accommodations on the intersecting roads during and after construction, but also the problem of lines, grades, clearances, roadway widths, types of construction, division of maintenance responsibility, mail delivery, school bus routes and a host of

other related problems too numerous to mention. Progress on projects has been delayed months on end for lack of management and consequently, lack of agreement in this area of the work.

Throughout the design phase of the project, despite the establishment of meticulous criteria and controls, unforeseen and new problems will arise from time to time which must be resolved with dispatch. As these problems develop, whether they have their genesis in design or policy, the decision on how such matters should be handled become the subject of directives to all engineers responsible for the design of the facility. It is incumbent upon those responsible for the management of a project to also maintain close liaison with the administrative authority responsible for the project, not only so the administration can be kept informed as to progress and furnish the necessary administrative decisions that are required, but also so management can be assured that the work is progressing in accord with administrative policies and precepts that have been laid down.

Upon completion of a set of plans and specifications for a particular construction contract, these documents must be reviewed and approved or modified. Bidding documents must be prepared, bidding time established, bids received and analyzed, qualifications of successful bidders reviewed and recommendations made to the administrative authority regarding the award or rejection of bids. Whereas these operations are usually routine, in a large project or program such as is contemplated the timing and scheduling of these procedures are of utmost importance. First of all, the flow of completed plans must be so scheduled and programmed to accommodate a realistic bidding schedule. In order to obtain maximum competition in the bidding and to give the highway constructors ample time to analyze the prospective job, the amount of work to be advertised and the time interval between lettings must be carefully reviewed and scheduled. It is of utmost importance, therefore, that engineering management establish such a schedule and exercise such direction and control on all elements of the work necessary to be performed to assure compliance with the schedule. In a large program, it becomes apparent that a loss of a bidding date through delays not only affects the one contract scheduled for letting, but has its impact upon subsequent lettings. A relatively short delay in the advertising and award of contracts can often result in as much as a year's delay in the opening of a facility to traffic.

During the construction phase of the project, it is the prime responsibility of engineering management to assure that the integrity of the schedule for the project is maintained. This involves not only periodic review of the progress of the several contractors involved but also, and relatively more important, the anticipation of problems in advance so that remedial measures can be developed and adopted in sufficient time to permit scheduled completion. Through continuous analysis of the job factors, management engineers can foresee difficulties that will arise and see to it that necessary steps are taken to offset them.

Obviously there are far too many facets entailed in this responsibility for mention here. However, there are a few typical conditions which are worthy of comment.

The problem of right-of-way and its implications has been discussed, but it is certainly of sufficient importance for reiteration here because during the construction phase, non-availability of right-of-way parcels has reached

the critical stage. It is recognized that it is not possible to acquire all necessary rights-of-way prior to the award of construction contracts. It is possible and necessary, however, to advise the contractors, prior to the submission of bids, of the parcels that have not yet been acquired and the times that such parcels will be available to the contractors. After award of the contract, particular attention must be directed to both the scheduled acquisition of the required parcels and the contractors' operations to assure, as far as possible, a continuity of construction operations and to be fully prepared against the possibility of claims.

In view of the fact that, in the prosecution of a highway project, the contractor must follow a sequence of major construction operations which must be performed in order, it should be ascertained, through analysis and review of the field progress reports, which contracts are not progressing satisfactorily and will become troublesome. By maintaining a finger on the pulse of the project in this fashion, additional equipment or other similar remedial measures can be instituted in sufficient time to protect the established schedule.

In addition to the construction operations, the management engineers must be in a position to know what the material requirements of the job are and the sources of supply for these materials. In light of the immensity of the proposed highway program, this is a very important factor. During the preliminary phases of the project, sources of supply, together with production capacities and demands, should be fully evaluated. Armed with this information, the engineers can ascertain whether a contractor's schedule is realistic or not and can determine the influence of this factor on the entire project. If and when bottlenecks become apparent, the engineer can be prepared through conferences with manufacturers, fabricators, suppliers and contractors to establish a material schedule to the best advantage of the project as a whole. It is vitally important that such procedures be undertaken early in the construction phase so that the necessary adjustments to be made by the parties involved can be planned and executed well in advance of the time that the materials are actually required on the job site.

Another function of engineering management is the direction and coordination of off-site material testing and shop and mill inspection. The programming and scheduling of these services must be carefully planned to accommodate the adopted schedule of progress. Although this may appear to be a simple matter, when the tremendous volumes of material incorporated in a major highway project, the myriad types of materials to be tested, the various tests to be utilized, and the manpower and equipment requirements necessary to accommodate a realistic construction schedule are considered, it becomes apparent that careful planning of these operations is a prerequisite to an orderly construction program.

It is also the function of engineering management to assure that inspection and supervision of construction is of uniformity high caliber throughout the project. In this connection, it is extremely important that the field engineers are robed with sufficient authority to permit them to make most of the engineering decisions on the job-site. In many instances, the ability and authority to make decisions in the field will eliminate lengthy and costly delays which often outweigh in importance the decision itself. However, it is mandatory that the management engineers fully instruct the field engineers in the administrative policies which must govern their decisions.

A further comment on field control has to do with field records and procedures. Obviously, field records and reports must be of sufficient scope to fully protect the project; however, the engineers responsible for over-all direction and control should assiduously guard against requiring too much paper work and superfluous reports which readily can and often have been classified as red tape. Such requirements at times have become so burdensome that the field engineers have been diverted from their principal functions in order to produce useless records.

Review and approval of partial and final payments to contractors, together with review and recommendations regarding contractors' claims, are the last of functions which are the responsibilities of engineering management.

The immensity of the highway program which has been programmed places tremendous responsibilities upon the highway engineers throughout the country who must direct, supervise and coordinate the development of the program. To a large extent, the success or failure of the program will depend upon the quality and integrity of engineering management.

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Journal of the  
HIGHWAY DIVISION  
Proceedings of the American Society of Civil Engineers

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OPERATING PROBLEMS OF MAINTAINING UNINTERRUPTED USE <sup>a</sup>

H. George Yeager <sup>b</sup>  
(Proc. Paper 1246)

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SYNOPSIS

The "Interstate System" of limited access highways will present motorists with the most modern routes man can presently devise. Unless maintenance and maintenance procedures are revised and amplified to provide uninterrupted use, freedom of movement and carrying capacity provided by construction, will be choked to a fraction of its potential.

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The theme of this paper is "A Forward Look". It is the recognition now that "to provide uninterrupted use of high-speed limited-access facilities requires application of and additions to usual highway procedures".

Few State Highway Departments have had such experience in the maintenance of extended mileages of high-speed limited-access facilities. The development of the National System of Interstate Highways will go a long way toward providing those facilities. Suddenly - overnight, so to speak - thousands of miles of the newest, most modern types of highway known to man are going to be made available to the traveling public. Proper maintenance, properly done, can be the greatest aid to the proper functioning of that Interstate System. However, maintenance and maintenance procedures must be amplified and added to if the nationally-sponsored Interstate System is to provide the carrying capacity and the freedom of movement that is required to throw off the shackles of congestion that have surrounded the Nation's traffic movement.

Anyone who has been intimately associated with maintenance of toll expressways has first-hand knowledge of what "Mr. Average Motorist" expects and - yes - demands, when he is given a limited-access highway. This paper deals with some of the problems which were faced and some of the "forward look" thinking that was used to solve these problems.

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- a. Paper delivered at ASCE Convention October 18, 1956 - Pittsburgh, Pa.  
b. General Maintenance Supt., Pennsylvania Turnpike Comm., Harrisburgh, Pa.

Most of the original Maintenance Department of the Pennsylvania Turnpike - from those in responsibility down to the actual laborers - were men with actual experience in the State Highway Department. Yet, with all of that resource of experience, they were immediately faced with the problem of providing uninterrupted use. Highway Maintenance Personnel generally has taken an attitude that, when his duties require him to be on the traveled portion of the roadway, he is there as a matter of right and it is the obligation of the motorist to avoid him and not interfere with the performance of his duties. When a motorist is traveling on a high-speed limited-access highway he has been lead to believe that he has an uninterrupted right-of-way. Cross-traffic has been eliminated, merging traffic has been controlled, opposing traffic has been eliminated; and he has been assured of an uninterrupted right-of-way. Unless the expressways are to be strangled or stagnated, the viewpoint and the attitude of highway maintenance personnel must be changed. It must first be recognized that when maintenance personnel occupies any part of the traveled roadway, they are there as a matter of sufference rather than as a matter of right. The worker must yield the roadway to the motorist whenever possible. In those cases where the roadway cannot be cleared entirely, it is necessary to interfere with the smallest part possible. Under these conditions the motorist must be given full and fair warning. Notice must be early, adequate, and extended. Control must be clear, concise and complete. For the motorist's safety, no obstruction can go unmarked. However, if the motorist is expected to respect the marking, it is just as important that no marking shall remain when the obstruction does not exist.

At this point, the theme of this paper is reversed by "looking back". Yes, 16 years ago this month, approximately 150 eager employees embarked on a project to maintain the "dream highway"; but it did not take long to find out that the problems were much greater than anticipated. The policy established by the Commission that first Winter, by early removal of the snow and cindering the entire roadway, designated the Pennsylvania Turnpike as the "All Weather Highway". This type of maintenance is most costly and requires much planning and use of labor-saving equipment for efficient operations. In order that the motorist has the least amount of delay, the snow removal operations on the Pennsylvania Turnpike are carried on by four (4) snow plow units, working in tandem, clearing the entire roadway and shoulders. These units allow a gap of approximately 1,000 feet between the second and third plows, which provides free flow of traffic with a limited delay. A crew of this type is assigned to approximately 15 miles of Turnpike. It must be kept in mind that the equipment must be provided, both to the front and to the rear, with ample, up-to-date lighting facilities. These units are supplemented with cindering crews to keep the highway safe at all times. During the Winter months, the Pennsylvania Turnpike is patrolled 24 hours a day, with maintenance personnel equipped to take care of all emergencies that may arise. During the Summer months, and prior to the snow removal and cindering operations, instructions are given and meetings held to acquaint all personnel with respect to the proper snow removal and cindering program.

After many meetings and discussions - including Police, safety, and maintenance personnel - a set method of standardization was established for the signing of the various types of maintenance operations. These were divided into two (2) groups: One, that operation which was classed as a Moving Operation; such as Line Painting, Joint Sealing, Shoulder Maintenance, or

any operation that would not be stationary for more than a three-hour duration. The second group was classed as Stationary Operations; such as Mudjacking, Slab Replacement, and all other operations that existed for more than three-hours' duration. The signing for the Moving Operation consists of sufficient signs, one-half and one-quarter mile in advance of the operation. These signs are also supplemented by a large 8' x 8' warning sign mounted on a moving truck. This sign is legible for 1,500 feet and is supplemented by flagmen placed in the immediate vicinity of the workmen. The signing for the Stationary Operation consists of one-half and one-quarter mile signs in advance of the obstruction, at which point small 30" signs are placed diagonally across the lane closed, in such a way as to permit the free flow of traffic. These signs warn the motorist of "Single Lane", "No Passing", "35-mile Speed Limit" and "Caution - Men Working". This same type of sign, cones, or reflectorized cards, are carried through the entire length of the operation and beyond the obstruction; and the motorist is also advised when he may resume normal speed. In the event this obstruction exists after dark, all signs are reflectorized or lighted.

In 1954, the Pennsylvania Turnpike Commission was confronted with a new problem of maintaining traffic for a resurfacing program, where both lanes would be closed, causing traffic to be diverted and creating single-lane traffic in each direction. After many meetings and the trying of numerous signs, a system of reflectorized and lighted signs was developed, which created a free flow of traffic with a minimum of delay. The contractor was required to plan his work so that at no time would he cause single-lane traffic to be in effect for a length exceeding three (3) miles. During three (3) years of this work, no serious accidents occurred.

There is no more similarity between the quality of maintenance to be provided on a high-speed limited-access highway and on a normal highway, than there is a similarity between the traffic-carrying capacities of these two types.

As stated previously, there are many problems of maintenance to provide uninterrupted use: such as smoothness of surface - corrected by mud-jacking, eventual replacement, and in some cases, resurfacing. Another and very important problem with regards to safety, is the continuity of the shoulders. It is the opinion of the Pennsylvania Turnpike Commission that on high-speed highways, shoulders should be treated by some method, to provide this continuity. Patrols must be provided at all times, so that any obstruction can be removed immediately, for safety and uninterrupted use.

There is no more similarity between the cost of maintenance of a high-speed limited-access highway and a normal state highway, than there is similarity between the original cost of these two types. Of course, these costs will vary, depending upon the services to be provided. As an example, the Winter Maintenance Cost on the Pennsylvania Turnpike for the Winter of 1955-56, was approximately one-fourth of the entire Maintenance Budget for that fiscal year.

Unless the facts are faced to the amplifications of and additions to usual highway maintenance procedures, the finest highway system could be built and immediately shrink its capacity by interference with traffic, making it partially or completely unavailable at times because of weather conditions, or letting it deteriorate to less than its original ideal by inadequate maintenance.

The slogan must be adopted, "Maintain in a condition as new". Preventive maintenance must be practiced. Failures should never develop - they should be corrected before they occur. It will be one of the greatest mistakes of America if billions of dollars are spent to build an Interstate System and this is not followed through by the spending of millions to maintain and perpetuate the investment.

Let this be the theme: "Amplify and add to the usual highway maintenance procedure so that the high-speed limited-access highway facilities will provide uninterrupted use".

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Journal of the  
HIGHWAY DIVISION  
Proceedings of the American Society of Civil Engineers

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LEGAL PROBLEMS RELATING TO CONSTRUCTION  
OF EXPRESSWAYS<sup>a</sup>

Joseph D. Buscher<sup>b</sup>  
(Proc. Paper 1247)

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SYNOPSIS

This paper points up the more important legal problems faced by the Highway Departments and the engineers in constructing expressways. Treated at some length are right of way acquisition and condemnation for future construction, "prior entry for construction purposes" and the right to exclude abutting property owners from access.

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All new adventures and revolutionary accomplishments require not only positive but forward-looking and progressive thinking, action and decision. This is true in connection with the construction of Controlled Access Highways and even today many of the Highway Departments throughout our United States are now pioneering in this field. History shows that ten years ago the construction and use of Controlled Access Highways, or Expressways, as they are commonly called, were practically unknown on a large scale, there being relatively few such highways then in use. Today there are a number of States in our country which are not now constructing this type of road.

It is safe to say that a number of States will initiate this type of construction as a result of the 1956 Federal Highway Act, which requires that in order to be able to obtain the Federal funds provided in that Act, the highways on our interstate system must be of a controlled access character.

For Controlled Access Highways we have to thank - and I say that advisedly -

- 1) The engineers for conceiving the idea.
- 2) The Legislatures for making the idea possible by the enactment of appropriate legislation.

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- a. Presented at Annual Convention of ASCE, Pittsburgh, Pa., October 17, 1956.
- b. Special Asst. Attorney General, State Roads Comm. of Maryland, Baltimore, Md.

The legal authority to build Controlled Access Highways stems from State statutes, State Court decisions, legal opinions of the several Attorneys General and legal opinions from attorneys for engineers and Highway Departments.

To be most effective in the accomplishment of this relatively new and much desired and needed type of highway construction, Highway Departments and engineers must have intelligence and broad-minded legal opinions that look toward the future. It is easier and safer for a lawyer to render a narrow and strict interpretation on any given statute because in so doing, he has little chance, if any, of being reversed by the Courts; but this narrow and strict interpretation is not conducive of fostering any new adventure or revolutionary project.

The opinion of the reactionary and backward, rather than the forward, looking attorney will lend little toward furthering our ultimate goal of an adequate highway system where our main routes must, if they are to include the ultimate in safety, embrace the feature of control of access.

The legal problems that face the attorney representing the engineer and the Highway Department are in many cases similar. The legal problems facing legal advisers to the Legislature differ from the problems facing the other group heretofore mentioned, in that, the Legislators concern themselves mostly with matters of policy. However, it must be remembered that a statute passed relating to the construction of Controlled Access Highways and the method of acquiring land necessary for these highways, must be constitutional. They cannot be in contravention of either the State Constitution or the Constitution of the United States and great care must be exercised by the legal adviser to the Legislature in the draft of those statutes in order to prevent a statute being passed that will ultimately be held to be invalid.

The legal problems that face the engineer and the Highway Department in connection with the construction of Controlled Access Highways are far too numerous to attempt to discuss or even list in a paper of a limited duration such as this. However, certain basic legal problems must be faced and legal opinions must be given to these basic questions and the purpose of this paper is to raise some of the problems that commonly confront the lawyer advising his client on this subject.

First, and it might be said of primary and basic legal importance in the construction of Controlled Access Highways is the question of title to land. Without going into this question in detail it is suffice to say that the State Agency that is going to construct this type of project must have valid, marketable title to the land or right-of-way which the highway will traverse, if it is the policy of the State to acquire the land in fee. If the statute of the particular State provides only for an easement for highway purposes, it is of prime necessity that when that easement is acquired, all of the attributes of access must also be acquired from any and all persons who might have an interest in the portion being used for highway purposes.

Another legal problem often asked is whether or not a Highway Department can acquire land by condemnation for future construction. It is a fact that the construction of a long section of highway requires considerable time. Often a number of years elapse between the start and the completion of a Controlled Access Highway project. It is also a known fact that the value of land increases almost daily and that this increase is to a large extent

occasioned by the presence of, or the anticipated presence of the highway. The right to condemn for future use in the absence of an express statute to the contrary has generally been upheld.

Mr. Justice Sanford speaking for the Supreme Court of the United States, said: <sup>1</sup>

"Public Roads System it is manifest must frequently be constructed in installments especially where adjoining counties are involved. In determining whether the taking of property is necessary for public use not only present demands of the public, but those which may be fairly anticipated in the future, may be considered."

In a recent case (1953) the Highest Court in Maryland held that the State Roads Commission of that State had the right to condemn land for future highway construction.<sup>2</sup>

The right to condemn for future construction has been upheld in a number of other States.<sup>3</sup>

Another problem often asked of attorneys for engineers and Highway Departments is whether or not construction may be commenced prior to the time right of way has actually been acquired either by purchase or condemnation. A number of States and the Federal Government now have provided for such a right. This has been accomplished by an amendment to the State Constitution or by appropriate legislative enactment, or both. It should be observed, however, that unless this right is granted by law, the Highway Department does not enjoy the right of possession for construction purposes until the land is acquired either by deed or by jury Inquisition resulting from a condemnation suit.

This right usually takes the form of legislation directing that the Highway Department deposit into the Registry of the Court its estimate of the value of the land taken plus the resulting damage to the remainder of the land, and in addition, filing with the Courts a description of the property taken.

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1. *Rindge Co. v. Los Angeles County*, 262 U.S. 700.

2. The Appellees specifically contend that as only one lane is being built at present, the Commission cannot condemn at this time the land later intended for the median divider separating the lanes of traffic, the land contemplated for the other lane of traffic, and the land necessary for grading that other lane of traffic. In building this one lane at present the Commission under the present construction is building cross-drainage structures across both lanes of the highway and grading is being done at present for the contemplated dual lane highway. As provided in Section 8(a), *supra*, the Commission by resolution passed on March 19, 1952, set out that it had approved the location and general design of the Baltimore-Harrisburg Expressway project in Baltimore County and that the land hereby sought to be condemned was necessary for that project. It appears therefore that the Commission has fulfilled the requirements of Section 8(a), *supra* \*\*\*\*. *State Roads Commission vs. Franklin*, 201 Md. 549.

3. *Clendaniel v. Conrad*, 3 Boyce, Del., 549, 83 A. 1036;  
*Woollard v. State Highway Commission*, (A), 249, S.W. 564;  
*Pittsburgh Junction R. Co.'s Appeal*, 122 Pa. 511, 6 A. 564, 567;  
*Vermont Hydro-Electric Corporation v. Dunn et al.* 95 Vt. 144, 112 A. 223, 226.

Generally speaking States operating under this procedure do not obtain title to the property upon the payment of the money into Court and the filing of the description. All the State obtains is the right of possession. Title does not usually vest until the Inquisition by the jury and the payment of the entire award by the taking Agency.

The Maryland Court of Appeals has held valid the section of the law that gives the State Roads Commission of Maryland the right of "prior entry" for highway construction purposes.<sup>4</sup>

It might be observed that under the general rules of law and applicable Court decisions the State Highway Department or the condemning agency may abandon a condemnation suit after the award by a jury, if, in its opinion, the award is excessive. In one jurisdiction, however, it has been held that where the State Highway Department takes land under its prior entry statute and pays the money into Court, that the owner, even though he is not divested of title, is divested of the right of use and that the State Highway Department cannot abandon such a case without the consent of the property owner.<sup>5</sup>

Another question often asked is whether or not the Highway Department has the right to acquire access rights, i.e. the right to exclude abutting property owners from entering upon the highway. This, of course, is the all important element necessary for the construction of a Controlled Access Highway. Normally, the right of access to property is a right recognized in the adjoining owner, and this right cannot be denied or taken away without due compensation.<sup>6</sup>

The right to deny access and to build roads of this type vests either from express legislative acts or from legal construction of statutes delegating certain authority to the Highway Departments of the several States. It is conceivable that in States where the Legislature has not expressly given the Highway Department the right to control access along its highways, that such power might be held to exist by proper legal interpretation of its several highway statutes, on the theory that the Legislature has delegated to the Highway Department certain of its police power to make it possible to construct its highways in such a manner as to provide maximum safety to its citizens.

It would appear unwise to commence construction of a highway having control of access features in a jurisdiction where the Legislature has not expressly granted that right, on an interpretation of the statute based upon the police power of the Highway Department, until the Court of last resort in that State has held such an interpretation valid.

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4. There is nothing here before us to show that this decision of the Commission to enter appellees' property before the condemnation trial was not justified. This suit was originally filed on April 4, 1952, and almost a year has now expired before the case has been submitted to the jury. It would be difficult to build roads under any systematic program if each owner could delay construction until he has exhausted his legal remedy as to the amount of damages due him by the condemnation of his property. *State Roads Commission v. Franklin*, 201 Md. 549.

5. *LaFontaine Heirs v. LaFontaine Heirs*, 205 Md. 311, 107 Atl. 2d, 653

6. *Elliott on Roads and Streets*, 3rd Edition, Vol. 2, P. 321, *People v. Ricciardi*, 23 Cal. 2d, 390.

In the State of Maryland it has been held that an additional express grant of authority by the Legislature was not necessary, because, under the general grant of authority imposed by the Legislature on that State Highway Commission, when it was founded in 1908, was sufficient in view of later statutes that defined the term "Expressway".<sup>7</sup>

Often legal advisers to Highway Departments have been asked how far and to what extent may the Highway Department go in building safety factors into roads. The question has been asked particularly in connection with location of roads and width of right of way. The answer to that appears to be that if there is no statutory limitation as to location or width it is left to the discretion of the Highway Department. The Courts in many jurisdictions have held that they will not impose their views upon the Highway Department.

In one case the Highest Court of Maryland, in speaking of the location of roads and of the authority of the State Roads Commission of that State had this to say:<sup>8</sup>

"As a necessary incident of the authority to determine the location of roads to be incorporated in the general system, the Commission is given the power of considering different roads and routes, and of selecting those which will in their judgment best serve the public interest, and ordinarily the only limitation upon the discretion, thus given, is that it shall be fairly and honestly exercised, and that private property may not be taken for an improvement for which there is no public necessity. Within those limits, whether wise or unwise, the decision of the Commission is conclusive and not subject to judicial review".

This doctrine has been followed in many other jurisdictions where express legislative limitation has not been imposed.<sup>9</sup>

It must be pointed out here, however, that the Legislatures of some States have, by express Legislative Act, limited the width of right of way its Highway Department might acquire by condemnation for highway purposes.

Another legal question which has vexed highway builders in recent years has been the right of the State Highway Department to construct median divider strips to separate opposite lanes of traffic. Property owners,

7. The Maryland Court of Appeals said:

"The appellees also claim that the Commission has no authority to deprive the appellees' property of all access to the public roads, including the so-called Baltimore-Harrisburg Expressway. Under the testimony here 50 acres of the appellees' property will be deprived of all access to the public roads. Under Section 7 of Article 89B, *supra*, the Commission in its judgment is given power to condemn, in any manner, 'rights or interests, franchises, privileges, or easements, that may be, in its judgment, desirable or necessary to complete said system of roads . . . .' It would seem therefore that the Commission has the power to condemn whatever property rights are needed for expressways as defined in Section 18(c), *supra*. Under the definition of expressway in Section 18(c), *supra*, one of the characteristics is '(c) points of access and egress limited to predetermined locations. . . .'.<sup>7</sup>" *State Roads Commission vs. Franklin* 201 Md. 549.

8. *Murphy v. State Roads Commission*, 159 Md. 7

9. *High on Injunctions*, Sec. 1240, *McQuillen on Municipal Corporations*, Sec. 390.

particularly farmers whose farm land lies on both sides of a highway and commercial establishments whose property is adjacent to points of access on a Controlled Access Highway, bitterly complain that their rights are effected, and that they suffer irreparable loss due to the presence of the median divider which prevents a cross flow of traffic. In every jurisdiction where this question has been known to have been judicially determined, it has been held that the median divider could be constructed and such construction does not constitute a compensable injury to the adjacent property owner.<sup>10</sup>

No discussion of legal problems arising by the construction of Controlled Access Highways could, in any manner, be considered complete unless the legal problems presented by the construction of Toll Roads be considered, for toll roads are always, and of necessity must be, Controlled Access Highways.

It is true that certain of the most recent constructed toll roads are falling short of their expected financial return and because of this, the present "money market" conditions, and the 1956 Federal Highway Law, it appears that the financing of toll roads by the sale of revenue bonds will be at least temporarily slowed down or halted. However, many authorities feel that ultimately there will be an ever increasing net of toll highways stretching across our country from East to West and North to South.

All of the legal problems that confront road builders in the construction of Controlled Access Highways confront the designers and builders of toll roads, and then some.

There are the legal questions that must be carefully considered concerning the financing which include questions relating to the issuance of revenue bonds to pay the cost of the project as well as providing for the creation of a Sinking Fund to pay the interest and principal of the bonds. This is a highly specialized field of law, and the legal questions relating to the financing of toll roads are and must always be answered by legal experts in this field, if the bonds are to find a ready market.

The legal problems of a general nature that must be considered about this type of construction will be more easy of answer if the lawyer keeps in his mind that the State, in such cases, owns only the bare legal title to the toll facility and the bondholders own the equitable title. The bondholders are usually represented by a Bank or Trust Company, as their Trustee, and their interest is protected by means of a Trust Agreement or "Indenture", as it is usually called.

This "Indenture" is a binding contract between the bondholders, represented by the Trustee, and the State Agency building the project, and contains certain covenants by the State that cannot be violated because to do so would be in violation of the Constitution of the United States.<sup>11</sup>

With this thought ever in mind, the attorney for the State Agency building the project must possess intelligence, broad-minded and farsighted legal

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10. *Rose v. State of California*, 19 Cal. 2d, 713, 123 Pacific 2d, 505  
*Holman v. California*, 97 Cal. Appeals 2d, 237  
*Brady v. Smith*, 79 S. E. 2d, 851  
*Langley Shopping Center, Inc. v. State Roads Commission of Md.*  
Opinion of the Circuit Court for Prince George's County, filed  
September 6, 1956.

11. Article II, Sec. 10, Constitution of United States.

ability to be of the maximum professional service to his client. During the preparation of the Trust Agreement careful and farsighted consideration must be given in order that the indenture be flexible enough to permit the sound and efficient operation of the project and at the same time adequately protect the interest of the bond purchaser.

An example of this intelligence and farsighted ability might be found in the "definition" of the project as included in the indenture. A project may be defined in such strict terms that the construction of an additional approach or connection to another project, however desirable and beneficial it might be, would be prohibited. Again covenants in the indenture prohibiting the construction of competing structures might be so drawn that the construction of an additional bridge or facility which would improve the outstanding bonds financially could not be built in spite of the fact that it would be most desirable to the traveling public. Also great care should be given to the drawing of the toll rate covenants so flexibility can exist in order that changes in rates can be made to provide that the project receive the maximum revenues.

Thus it can be seen that intelligent and broad-minded legal foresight is a necessary prerequisite for the construction of toll projects.

The final legal problem that will here be discussed relates to right of way payment and compensation. The legal principle surrounding right of way compensation applies to both free Controlled Access Highways and Toll Roads.

Before engineers and Highway Departments can determine the estimated cost of a Controlled Access Highway or Toll Road they have to know for which elements of damage the property owner is entitled to be compensated and for which elements the Constructing Authority does not have to pay.

The Courts have defined measure of damages as follows:

"Measure of damages for value of land taken in condemnation proceeding is ascertained by comparing fair market value of the whole land before the taking with the fair market value thereof after the taking, excluding from consideration any enhancement in value resulting from the utilization of the land taken for the purpose for which it was taken."<sup>12</sup>

It is realized that this definition is illusive and leaves many questions unanswered. In every State and in every Federal District numerous cases have been decided by the Courts on this subject and it is impossible to provide here an all inclusive definition. In fact, the law of right of way damages in some respects differs between the States.

Generally speaking, however, the property owner is entitled to be compensated for the value of the land taken plus consequential damages to the remainder of his property if the residue is damaged because of the highway. The taking agency must pay for denial of access, damage to the remainder of the property because of grade change and adverse drainage conditions. In some cases the entire character of property may be changed or the property left inoperative because of the presence of the highway. In such cases the owner is entitled to compensation.

On the other hand if a property is adversely affected because of the presence of the highway but there is no actual taking of land the owner is not

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12. 170 A. L. R. 709.

entitled to compensation in the absence of a statute to the contrary. Likewise, if a Controlled Access Highway is built around a business section or the highway built in such a manner to divert traffic away from a business district, then there is no compensable damage.

In determining highway costs the expense of removing and relocating public utility facilities must be determined. The general rule and the common law rule is that if the public utility is located on the highway right-of-way and it has to be removed or relocated, the cost thereof must be paid by the utility company. In the absence of a statute to the contrary this law is almost universal in all the States. In an examination of 250 cases arising in many States, only one State Court was found to hold otherwise. That State is Kansas and even that case can be distinguished by careful study.

This same principal of law is applicable in the construction of toll roads. A leading case on this subject is found among the decisions of the Highest Court of New York.<sup>14</sup>

If, however, the State is constructing a proprietary project such as a City owned parking garage the constructing agency has to pay this cost.<sup>15</sup>

The trend in recent years, however, insofar as toll projects are concerned is for the legislation authorizing the construction to provide that the agency doing the construction pay the cost of utility relocations. This is the condition in the case of the Ohio, Indiana and Illinois Turnpikes.

The answers to many of the specific right of way compensation questions can only be found after study of the various State statutes and a review of the Court decisions of the particular State.

This paper has not been a review of all the legal problems associated with Controlled Access Highways nor is it intended to be a legal treatise on any of the problems discussed. It is hoped, however, that for those who are concerned and interested that it will serve as a starting point for further research and thought.

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14. New York City Tunnel Authority v. Consolidated Edison Company, 295 N. Y. 467

15. Matter of City of New York (Gillen Place) 304 N. Y. 215

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OPERATION PROBLEMS ON CONTROLLED ACCESS HIGHWAYS<sup>a</sup>

Charles M. Noble<sup>b</sup> M. ASCE  
(Proc. Paper 1249)

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SYNOPSIS

The paper emphasizes the advantages of the controlled access highway and outlines the facilities necessary on such highways to provide for the comfort and safety of the travelling public.

Motor fuel, water, food, comfort, policing, fire department, communications, traffic operations, first aid and ambulance, wrecking, flat tire and towing services are described and the necessity for making these facilities available is stressed.

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Bitter experience in populous areas has demonstrated conclusively that control of access on major travel arteries is a vital necessity. Lack of such control results in a rapidly depreciating highway not only in volume but also in facility of movement and safety. The economic loss due to such depreciation is enormous. Today modern express highways adequate to cope with current and prospective traffic volumes and speed cost so much money that the nation can no longer afford deterioration and obsolescence. The highways built today must maintain their efficiency and safety indefinitely. The tragic loss in death and injury is reason alone for the controlled access principle. But in addition to this compelling reason, the controlled access highway is a builder of economic health and a developer of the region through which it passes. This economic upbuilding has been proved over and over again throughout the nation and now can no longer be open for debate. The upsurge of development is so swift that rural countryside is transformed in a few years to bustling prosperity, dramatically demonstrating the urgent need of access control to preserve the economic value and safety of the traffic artery.

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One of the major objectives of the controlled access highway is to relieve obsolete and over-crowded local highways by diverting through traffic, but without destroying business generated by the automotive vehicle. Freeing local traffic ways from interference of that segment of through traffic not desiring to stop, will make more street space for those vehicles that wish to pause for service, shopping, recreation and overnight accommodations. The slogan "every vehicle a customer" can have meaning if broad public interest is recognized and controlled access planning includes provision for services for the travelling public.

Control of access introduces new problems in administration and operation that at first may appear formidable but which will yield to informed planning and organization. The passage of the Federal Aid Act of 1956, which features the Interstate System of Highways (a 41,000 mile network) places the problem of operation before highway administrators. Intra-continental Expressways traversing both rural and urban areas preclude promiscuous exit and entry and planning for many services and necessities hitherto considered beyond the field of the highway official now must receive careful and thoughtful consideration. In a sense, the highway administrator will have the public in his care. Consequently the "OPERATION" of such highways has now become an important issue.

It would appear quite logical for highway departments to establish an Operations Division, with a Director of Operations. This operating division may become as important and render as essential service as the operating department of major railroads. It seems likely that it will take its place beside design and construction as a major activity in the highway department. Express Highway operations include a variety of activities now handled by various and often uncoordinated organizations, the principal items of which are:

1. Traffic Operations.
  - a) Safety surveillance.
  - b) Safety programs.
  - c) Accident investigation and analysis.
  - d) Development of safety measures.
  - e) Signs, signals and markings.
  - f) Accident statistics and reporting.
2. Policing.
  - a) Accident prevention.
  - b) Enforcement.
  - c) Aids to motorists.
  - d) Crime detection.
3. Communication.
  - a) Radio.
  - b) Television.
  - c) Roadside public telephones.
4. Service.
  - a) Fuel, water, oil, accessories.
  - b) Comfort.
  - c) Food.
  - d) Repairs, flat tire, towing.
  - e) Fire.

- f) Ambulance, medical.
- g) Overnight accommodations.

5. Maintenance.

- a) Roadway repairs.
- b) Roadside care.
- c) Structural repairs, painting.
- d) Drainage.
- e) Snow removal and ice control.

### Traffic Operations

Traffic operations are established now in nearly all highway departments but will assume new and challenging responsibilities in the years ahead under the leadership of trained traffic engineers. Intelligent analysis of traffic needs and constant surveillance can result in reduction in accidents, the saving of human life and the comfort and satisfaction of the motoring public.

### Police

Policing is an essential function that must be integrated with operations. Although State Police usually operate under a different department of State Government, there is no reason why this function can not be closely coordinated with highway operations. This is evidenced by completely successful integration of the 88 man State Police detachment assigned to the New Jersey Turnpike. This detachment monitors all Turnpike operations at headquarters through the micro-wave Turnpike radio system which in turn is connected to State Police headquarters and the Pennsylvania Turnpike radio system. The police operate on an around the clock schedule and are an effective task force for traffic regulation, enforcement and criminal detection. They must be at the scene of all accidents not only to investigate the accident and apprehend violators but to direct traffic, render first aid and summon wreckers, fire apparatus, ambulance and first-aid squads. Police contribute substantially to accident prevention by halting drivers that are driving unsafely or that are intoxicated or sleepy. Many lives have been saved by this activity. Police are also a service force in affording protection to stranded motorists summoning aid for gasoline, flat tire or repairs and often helping the motorist to start his car. This adds tremendously to the safety, comfort and convenience of the traveller and enhances the economic benefits of automotive transportation. In the year 1955, 44,000 stranded motorists were aided by the police on an eastern Turnpike.

### Communications

More than ever communications will be vital to successful operations on the highway system. Radio with accompanying dial radio phones, teletype and facsimile will be indispensable. In some urban areas with dense traffic, television surveillance may be necessary to detect instantly accidents or other disturbances so police, ambulance, fire department or other aid may be dispatched to the scene immediately. Protracted tie-up of the traffic stream results in heavy economic loss when large volumes of traffic are involved. In

rural areas, roadside telephone stations equipped with acceleration and deceleration lanes will add to the safety, comfort and convenience of the public.

### Service

In the past, controlled access highways, except Turnpikes and certain Parkways, have been limited to relatively short mileages in urbanized areas. Existing urban Expressways in addition to being short are accessible to municipal and private enterprise facilities including police, fire department, ambulance, medical, fuel, repair, eating and overnight accommodations. Frequent entrance and exit points in built up areas make these services readily available. On the other hand, long distance controlled access highway systems currently on the drafting boards introduce a new public problem which merits attention.

Because it is not necessary to develop self-liquidating revenue from highway services on the Interstate and Urban Systems, existing private facilities can be utilized to the utmost. It would seem that national highway policy might well be based on the principle of disrupting existing private enterprise facilities and plant to the least extent possible. This can be done by informed planning during the design stage at the inception of each project. Thus the highway administrator has the option of developing policy in each state and region tailored to local needs and in the public interest. It is believed that proper perspective in assuming these new responsibilities would consider each motorist a "customer" to be served.

Utilization of existing services developed by private enterprise relieves the public highway agency of many annoying and detailed responsibilities. On the other hand, over-all leadership, coordination, supervision and regulation will be necessary to assure the safety, comfort and convenience of the motorist public.

In most cases it will only be necessary for the State to survey existing privately owned servicing facilities, coordinate, establish zones of operational responsibility and make satisfactory arrangements concerning prices charged, quality and scope of services. Thereafter, continued follow up and review will be desirable to assure adequate and satisfactory service to the public.

The magnitude of motorists' needs may be visualized when it is realized that the services required by a city of 200,000 population constitute daily requirements on a Turnpike. These persons occupy an average of over 86,000 vehicles with peaks of 125,000 vehicles per day. This city on wheels is in motion but it must stop at intervals for essential services. All facilities of a modern city are required. Buildings, food, motor fuel, accessories, water supply, water treatment, commercial electric power, standby power, telephone, sewage treatment, garbage disposal, comfort facilities, radio, heating including standby units, air conditioning, lighting, parking air and water must be available, all of which items are taken for granted by the city dweller.

A cardinal principle has emerged. The public are loath, in fact, will not leave a major highway in search of such facilities unless assured that acceptable services can be reached along a well maintained and marked route. Consequently, it becomes necessary to integrate these services into the over-all highway plan so the motorist may be offered complete service for his comfort, safety and convenience. Searching for service in strange territory, particularly at night with the probability of getting lost is distasteful to the public and not acceptable.

Fuel, oil, air, water, comfort and repair services must be available at reasonable intervals, and if the highway is of extended length, food facilities are necessary. In addition, fire department, towing, sleeping facilities, wrecking, ambulance, first aid and "out of gas" roadside services are required if the motorist is to be served. Communications are more vital than ever. Many women, elderly and infirm persons drive motor cars, and servicing arrangements should be designed around the requirements of such people.

The handling of this problem calls for statesmanship of a high order in establishing policy, which will accord fully with the public interest and in the development of procedures that will assure scrupulous honesty and impartiality in administration.

To insure the greatest economic benefit to the travelling public and the business community from the National System of Interstate Highways, operational planning for controlled access highways will revolve around existing privately owned and operated services, so that the construction of such highways will result in improved business and healthy land development.

Acquainting the motorist with the availability of roadside services as well as shopping or recreation facilities is equally as important as placing traffic warning and destination signs. Certainly dignified legible signs advising the traveller in advance the name of the community being approached and of the availability of comfort, food, fuel, overnight and shopping facilities will be an acceptable public service. In addition, a well marked, adequate and properly maintained access connection from the controlled access highway to the community center is imperative. Parenthetically, some sort of system needs to be developed for advising motorists "on the fly" of the availability of overnight accommodations. Certainly no motorist will desire to leave the through highway only to be greeted with a battery of "No Vacancy" signs. Lack of positive information on where to find sleeping quarters tempts the motorist to keep on driving beyond the fatigue limit, a condition which should be avoided. By the same token no motorist wishes to be directed to third rate or criminally dominated facilities. This imposes a responsibility on the part of the roadside industry and community officials.

Where adequate facilities are not available at intervals frequent enough to satisfy public convenience the State may then provide "Service Areas" adjacent to the Expressway. Such areas might be planned in conjunction with an interchange. Contrary to practice on Turnpikes it is believed areas financed by the State may well be provided on a simple "Recovery of Cost Basis" and not used as revenue producers. That is, it would seem good public policy that facilities be provided solely as a service to the public and not for the purpose of raising revenue.

The plan developed by a State Highway Department for freeways and parkways was for the State to design the site, acquire the necessary land, grade, drain, pave and landscape the area, bringing in the necessary utilities such as electric power, telephone, water, etc. The site was laid out in lots each suitable for a complete "gas station." It was proposed at first to lease these lots on the basis of competitive bids to individuals, who would construct the buildings, gasoline pumps and other accessories, at lease rates sufficient to amortize the investment and provide for annual maintenance. Prospective lessees objected to the principle of constructing permanent buildings on land owned by others and the procedure was modified. The lots were offered at public sale, each lot going to the highest bidder, but not more than one brand

of petroleum product was permitted in each area. Building architecture and signs were required to be approved by the State Highway Commissioner. In practice each site was laid out with four lots initially but with provision for two more, which could be added any time in the future the public interest would require.

Publicly provided fixed plant roadside service will probably be confined to two essential items:

- a) Fuel
- b) Food

Facilities for dispensing fuel, oil and road accessories are required on all highways except very short projects, probably less than ten miles long although no general pattern can be, or at least, has been established. Environmental conditions on each highway are different and a service area policy needs tailoring to the peculiar requirements present on each project.

Food service is required on the longer projects particularly through rural areas. Again no rule can be applied but it would appear that food facilities would not be required where facilities are available at forty to fifty mile intervals.

Deluxe type overnight accommodations have not been provided so far on controlled access highways and there is considerable doubt whether they are required with the possible exception of bunk space for tired truckers. It is believed that the provision of sleeping accommodations should be approached with great caution. The problem is fraught with many pitfalls and it is hoped that some workable solution can be devised without involving the highway agency in a business, particularly well suited to construction and operation by private enterprise.

Controlled access highways on which service facilities have been integrated into the highway fall into two categories:

- a) Freeways and Parkways operated toll free.
- b) Toll highways.

In the first case service, not revenue, is the controlling consideration. In the second, revenue and service are of equal importance since most toll projects must be fully self-liquidating.

It would also seem that no on-the-road services should be provided not immediately essential to the safety and requirements of the travelling motorist. Such policy should cut short any tendency toward paternalism and restrict facilities to "essential services" only.

In addition to "fixed plant" service areas, it is necessary to make arrangement for patrol services for breakdowns, flat tire and out-of-gas cases, and with garages for repair, towing and wrecking services; first aid, ambulance and fire department availability. The scope of the "gas" patrol is indicated by yearly travel of 600,000 miles resulting in aid to 28,000 distressed motorists on a Turnpike. In addition, 45 private towing and repair garages responded last year (1955) to 15,000 emergency calls, 22 fire companies 80 calls; ambulance and hospital squads responded 323 times.

#### Design of Operational Facilities

Controlled access highways will, in general, be constructed with a median

separating opposite direction traffic and with all crossings grade separated. In urban areas many long viaducts will be constructed. These features make it necessary to provide operational facilities in the original design.

Police, towing, wrecking, ambulance, fire department, roadside gasoline patrol service and maintenance operations require crossovers in the median. Without this flexibility, the effective operation of servicing units will not be feasible to a degree that will be satisfactory to the operating forces and the travelling public. After coordination of police and maintenance patrol districts, crossovers should be placed at section limits, at locations where snow and ice control trucks need to reverse direction, and to care for wrecking, fire department, ambulance, etc. services. Usually crossovers are needed at each end of an interchange area so snow and ice equipment may reverse direction quickly to clear all entrance and exit ramps.

Extraordinarily wide medians with topography or vegetation between that obscures vision from one roadway to the other present operating problems to patrol and policing personnel which require consideration. Crossovers at each end of such medians are needed to permit "loop" operations by personnel for observation to detect broken down motorists, accidents or criminal operations. If "obscured view" medians are of considerable length intermediate crossovers will be required.

Crossovers should be inconspicuous as possible to prevent use by the public, paved suitably and with adequate drainage and other design features so maintenance costs are not excessive. For enforcement purposes signs prohibiting public use are required, such as "NO U-TURN - FOR OFFICIAL USE ONLY."

Between interchanges, emergency "Escape Hatches" are required at appropriate locations to care for entry and exit of emergency vehicles but where public entry is not desired. Emergency entrances are life savers when disaster strikes. These ramp points of modest and rudimentary design are located strategically to the local road system, fire departments, ambulance service, local police stations, garages, wrecking and towing services. In order to prevent unlawful entry into a controlled access facility, the ramps may be fitted with locked gates and keys distributed to dependable and responsible personnel. In addition to prompt entry of ambulance, fire, towing, garage and police vehicles, it may be necessary to by-pass maintenance and police around trouble spots where large numbers of vehicles are stalled in spectacular accidents or in unusual blizzards. Often motorists and truckers will abandon vehicles in the roadway, thus blocking all movement and it is necessary to get to the head of the line quickly and pull stalled vehicles off the roadway.

Special features may be required on long viaducts where adjacent development precludes plowing snow over the side. Many such viaducts require the snow to be loaded on trucks and carted away.

Rest areas are important and add appreciably to the safety and comfort of the public. Sleepy and tired drivers need to pull off the highway for rest and sleep. Other motorists desire to eat a packed lunch and relax during the journey. Rest areas fill a real public need. They should be set back from the highway preferably with shade trees, picnic tables, public telephones and comfort facilities. Fencing may be required to prevent small children from venturing on to the adjacent main roadway. Importantly, acceleration and deceleration lanes are required for exit and entry to the highway.

Bus stations set off to one side with adjacent parking yards contiguous to

the street system will be necessary on many portions of controlled access highways. They must be equipped with acceleration and deceleration lanes. Unless mass transit is encouraged it will not be possible for highway facilities to meet peak hour morning and evening demand.

Pedestrians do not comprehend the hazard of crossing wide modern highways nor do they have sufficient perspective to judge the speed of approaching vehicles. At locations where pedestrians will cross regardless of regulation but where a grade separated vehicular crossing is not justified, overhead pedestrian bridges provide a solution. These structures may be light structures, possibly of suspension design with open floor to avoid snow loading and icing hazards. In urban areas it may be necessary to enclose the crossing with wire mesh to prevent stones being thrown at vehicles passing below. Where feasible such bridges should have ramp approaches, not steeper than 10% gradient, rather than steps. The public are very loath to use steps and will often cross the road at grade rather than use stairs.

Bridge railings in urban areas have been the occasion of unfortunate public debate particularly when popular emotion reaches a high pitch. Highway authorities in an effort to design sightly structures aesthetically pleasing to the public have at times produced a railing that parents believe is hazardous to small children. Rails with openings that toddlers can crawl through or roll under and older children can walk on have been the subject of attack.

Right-of-way fencing to define the limits of public property, prevent unlawful entry and stop stock from straying on the highway is receiving attention. Generally farm type fencing is adequate. In urban areas where children are present, the chain link type may be required and in special cases 6 foot to 8 foot chain link surmounted by barbed wire may be necessary. At deer runs, fence 12 or more feet in height is required and in some cases underpass culverts may be needed to allow the deer to cross. Deer are becoming so numerous in the United States that the situation presents a problem due to the serious accident potential.

Utility crossings present another problem calling for mutual cooperation and planning between utility owners and the highway department. Such crossings should be planned so it will be unnecessary for utility employees to work within the highway right-of-way after the initial installation. The hazards to these employees and the public are so great after the highway is opened to traffic that full cooperation should be assured. Underground crossings can be put through in outer sleeves. In cases of breakage or need for replacement, the utility line can be withdrawn from the sleeve while working outside the right-of-way.

During the initial construction sufficient right-of-way should be purchased for interchange expansion. Never will property be any cheaper than at that time and it is surprising how quickly traffic expands to the point where additional facilities are needed. This also applies to right-of-way required for future widening operations.

### Maintenance

Maintenance on an Expressway is different from that on local rural roads, not only because of heavier traffic volume and high speed operation but due primarily to the attitude of drivers utilizing the facility. They feel they have the "right of way" and are intolerant of any operations on or occupancy of the

roadway. Density and high speed have intensified the necessity for designing maintenance into the modern Expressway so as to reduce occupancy of the roadbed by men and equipment. Full mechanization is necessary not only for efficiency of operations and conservation of labor but also to promote public safety. Machines, when equipped properly and operated carefully, reduce hazards of maintenance. Thus, it is necessary to take a fresh look at maintenance procedures devising and employing special measures when performing maintenance operations on controlled access roadways.

Each maintenance task should be analyzed to determine whether the work can be effectively done by machine or other mechanical equipment. For example, ice control chemicals and abrasives can be handled by one man operated special-body trucks, equipped with mechanical spreaders under cab-control by the driver. These units can be organized to insure quick action necessitated by the high degree of service required on modern highways and assure top efficiency. The trucks can be loaded in eight to ten minutes by mechanical loaders or by overhead storage bins.

Where standard commercial equipment is not available on the market, for particular tasks, special equipment can be developed in cooperation with reliable and experienced manufacturers.

Preventive maintenance, to as great a degree as feasible, must be designed into the Modern Expressway. High quality, tough and durable pavement that requires a minimum of surface maintenance is desired and hard surfaced shoulders flanked by adequate grass covered berms eliminate the necessity of scraping and blading. This increases safety to the motorist who must drive onto the shoulder at high speed and also because of elimination of men and equipment working on the shoulders at frequent intervals. Open ditches should be eliminated and except in rock or mountainous country, side slopes that are to be mowed should be no steeper than 3:1 with all "breaks" rounded. Erosion control assumes important proportions on the large areas involved in trunk highway construction. All slopes and disturbed areas should be planted with grass seed and clearing carried back sufficiently to avoid falling trees encroaching on the travel lanes. All slopes and grading at drainage structures should be streamlined not only for increased vehicle safety but to facilitate the movement of grass mowing machinery. Drainage pipe systems including inlets, designed on the self-cleaning principle with a minimum velocity of 3 feet per second when flowing one third full, will reduce maintenance. Liberal use of underdrainage to keep the water table down is of great importance, particularly in wide medians where so much water percolates underground.

All maintenance operations conducted within the roadbed from shoulder to shoulder must be surrounded by safeguards to reduce the chance of accidents to the absolute minimum, particularly those involving the public. Large signs repeated at regular intervals and traffic cones are used to mark every operation; and flagman protection is essential. Elaborate set up and flagging service cost money but they are well worth while when viewed from the standpoint of public safety.

The "following truck" principle is utilized while applying traffic paint lines, work within the roadway areas and when mowing grass on narrow medians. A typical set up is as follows. All pavement traffic paint lines possible are placed with a large truck applicator. Following immediately behind the applicator is the supervisor's truck and behind that is a truck placing traffic cones, at 50 foot intervals. This truck has an 8' x 3' "CAUTION MEN

**WORKING"** sign. At the beginning of the operation where the paint has dried is a fourth truck on which is mounted an 8' x 6' sign with letters ranging from 12" to 20" high with the message "SLOW-KEEP OFF WHITE LINE - KEEP RIGHT (OR LEFT) - 35 m.p.h." In addition the two preceding signs have red flashing blinkers mounted on them. At the very beginning of the entire operation is a stationary sign 6' x 4' with 10" letters reading "SINGLE LANE - 4 MILES."

These trucks and signs following the paint truck not only protect the crew on the paint truck but importantly, reduce the chances of rear end collisions even in the case of somnolent drivers since the attention getting signs are visible for approximately a mile ahead. Work on the pavement on dense traffic routes usually can not be started until about 9 A.M. and must usually terminate by 4 P.M. otherwise traffic tie-up would be intolerable. If work is attempted beyond those hours more traffic than can be handled by the restricted roadway causes back up and stoppage of vehicles. This back up of stationary vehicles is an invitation to rear-end collisions.

There is evidence of motorists who continue driving on the road after reaching exhaustion and who drive in a state of somnolence, often actually dozing at the wheel. Although police are constantly on the alert for these drivers, nevertheless enough of them remain undetected to be a menace. Therefore, maintenance operations must be planned and safeguards set up in anticipation that a driver may drive straight into a stopped vehicle, sign or other object in the road. Flagmen, for example, must stand clear of signs and barricades since they would be endangered by flying pieces and they must always stand facing traffic, watching each approaching vehicle, constantly on the alert.

All operations on the modern highway should be conducted under the policy that the safety and comfort of the motorist comes first and maintenance and construction must be second.

It goes without saying that snow and ice removal operations must be prompt and so organized that no more than an inch or two of snow is allowed to accumulate. High speed plows, painted for maximum visibility under murky conditions and equipped with powerful jumbo-sized flashing red lights, usually operate in echelon, "floating" in the traffic stream. A special set up is needed at interchanges for prompt snow and ice control. An interchange plugged with stalled or stuck vehicles during an ice or snow storm can cause an emergency of vast proportions.

U. S. weather and airport weather reports are utilized extensively to give the maintenance man a "jump" on the weather. Today more and more states are employing specialized, personalized, professional weather services. A foolproof system of dissemination is essential. Many states have arrangements with commercial radio stations as a public service to broadcast adverse weather and road conditions. This adds immeasurably to the convenience and safety of the public.

## CONCLUSION

Highway transportation is entering a new era in which operations will assume new and challenging proportions. Exciting and rewarding days are ahead not only in the field of design and construction but also in operations and administration. The new tasks and responsibilities generated by the

Expressway may seem burdensome but when viewed from the standpoint of public service involving the comfort and safety of the travelling public, they are eminently worth while. These developments should be welcomed, not feared, since they demonstrate the dynamic character and maturity of highway transportation. Particularly, there is deep satisfaction in the reduction of injury and death on the highway. Adequate designs and alert operation and administration will result in accident reduction as evidenced on an eastern turnpike where in 1956, the fatality rate was 2.3 per 100 million vehicle miles compared with the national rate of about 6.0, and an accident rate of 93 1/2 which is 6% of the national rate.

#### APPENDIX A

Facilities on toll highways must be self-liquidating as well as give essential service to the public. Two methods of development have been used:

- a) The Turnpike Agency obtains bids from prospective operators on the basis of the Agency purchasing the ground for sites but with the operator developing these sites with paving, acceleration and deceleration lanes, etc. and constructing the buildings with his own funds. In these cases, a single firm often contracts to operate both gasoline and food facilities.
- b) The Agency obtains separate bids for gasoline and food with the Agency furnishing site and buildings.

When the operator furnishes buildings and site development, stipulation is usually made that the design and appearance shall be subject to the approval of the owning Agency and that the investment shall be amortized over a period of years at the expiration of which all facilities become the property of the Agency. Contracts usually run for a set term of years with renewal or re-advertisement at the option of the Agency. Prices are usually required to be no higher than charged on parallel open highways. In addition to fuel, a line of tires and on-the-road accessories are usually carried for the convenience of the public.

When the Turnpike Authority provides the site and all other facilities except silverware, dishes and movable accessories, the specifications accompanying the call for bids spell out the working arrangement between the Agency and the operators concerning maintenance, repair, renewal, re-decoration, fuel, electricity, operation of heating, air conditioning plants, wells, water purification plants, sewage purification plants, snow removal, etc.

Service facilities require careful design based on handling large numbers of people on a 24 hour, round the clock, 365 day per year schedule. Some idea of the scope of the problem may be gained when it is realized ten service areas along a Turnpike have served 11,000,000 meals and sold 18,000,000 gallons of gasoline a year. Mediocre facilities can not handle such patronage.

A service area should be located on ample ground (22 1/2 acres is none too large) suitably landscaped, set well back from the highway and equipped with acceleration and deceleration lanes. Adequate sight distance and avoidance of adverse grades and alignment are important factors in site selection.

On the Turnpike there are 145 restaurant seats and lunch counter seats

and 23 motor fuel pumps for each 100 million vehicle miles of travel. There is one meal served and 1.8 gallons of gasoline purveyed per 100 vehicle miles of travel. About one third the gasoline used in travelling the Turnpike is sold at the service areas. In 1958 after completion of new facilities and based on estimated traffic there will be 123 restaurant seats and 22 motor fuel pumps for each 100 million vehicle miles of travel. These figures should be used with care since this is an urban state and many motorists are served locally and not on the Turnpike.

The actual operation of the facilities is conducted on a lease basis by private enterprise specializing in the field.

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THE USE OF TECHNICIANS IN HIGHWAY ENGINEERING

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SUMMARY

This article stresses the importance of making the best possible use of non-engineers and engineering technicians, as the only solution to the problem of continuing shortages of engineering graduates.

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For many years the California Division of Highways has realized the necessity of maintaining a high caliber, professionally competent engineering organization. Up until recently, the fundamental classes included in the organizational structure have provided for three levels of engineering aids (Under, Junior, and Senior Engineering Aid) and six regular engineering levels (Junior Civil Engineer and Assistant, Associate, Senior, Supervising, and Principal Highway Engineer) under the definitely administrative grades of Assistant State Highway Engineer and higher (see Figure 1). The Junior Civil Engineer class has been the entering level for the new college graduate. Registration in California as a civil engineer has been required for all engineers at the Associate level and higher, the Associate grade being the class used to fill resident engineer assignments in the field or design squad boss assignments in the office.

In recent years two trends have accelerated continuously, both of which have had considerable effect on the analysis of our over-all program of personnel administration. In the first place, our construction program has been increased many times—from about \$25,000,000 a year in 1945 to \$350,000,000 a year now, and \$500,000,000 a year is anticipated in 1960. At the same time, the shortage of trained graduate engineers has become more and more acute. While the demand from all units in the organization has increased in tempo because of the increased work load, the supply of college graduates available to us has actually decreased.

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Analysis of these mutually aggravating trends and their effect on our engineering organization convinced us some years ago that drastic steps would have to be taken in several areas. The most important actions considered to be necessary in order to get the work done with the help available were as follows:

1. Make sure that as much as possible of the work which had to be done was handled by non-engineers.
2. Make sure that the best possible use was being made of engineering technicians so that the available engineers could be spread thinly enough to care for the true engineering work.

Neither of these problems could be solved in its entirety by the Division of Highways alone, since in California all state employees are under civil service and the State Personnel Board is responsible for such things as job classification, pay analysis, administration of examinations, establishment of new positions, etc. As a result, a good deal of cooperative work between the Division of Highways and the State Personnel Board was required before the steps discussed below could be taken.

In approaching the first item mentioned above: "Make sure that as much as possible of the work . . . was handled by non-engineers," the primary problem was one of attitude on the part of a large proportion of our supervisory personnel. Raised in an organization primarily made up of engineers and during a period (particularly during the depression years) when engineers were plentiful, the automatic approach to the analysis of a new position too often was not: "Is the work clerical, accounting, engineering, or administrative?" but simply: "What grade of engineer do I need to get this work done?"

This attitude on the part of supervisory personnel was natural, but it was something that had to be revised if we were to accomplish the work which was our responsibility. Both Highways and Personnel Board representatives have stressed the revised approach whenever old positions have come up for re-filling or the need for new positions has become apparent. As a result, many individual job assignments have been changed so that duties previously handled by engineers now are performed by non-engineering employees. In a number of cases new classes or series of classes have been set up to tap new sources of employees. One illustration is furnished by the new Bridge Painting Inspector series. This is a three-level series (I, II, and III) which was set up two or three years ago. The men in these classes do inspection of bridge painting which was formerly handled by civil engineers in our Bridge Department. They are recruited from the painting industry and have proved to be able to do this work in an entirely satisfactory manner. This type of class is just being expanded to the field of bridge construction inspection, and we are exploring the possibilities of generalizing even more and using some highway inspectors with craft rather than engineering backgrounds.

Many other individual and group situations of this type probably exist, and their possibilities are being analyzed on a continuing basis. Sometimes, however, individual cases can be complicated by personality factors which delay a desirable solution. Also, it must be realized that, while results in this area are often satisfactory and sometimes spectacular, there are very definite limits. Such action can only be taken where definite non-engineering work exists.

Making progress in the second field: "Make sure that the best possible

use was being made of engineering technicians . . .", is a much more complicated procedure than the other but in some ways offers much more promise as well. Many students of the causes and effects of the current well-advertised shortage of engineers even go so far as to say that if all employers of engineers would just use the engineers they have to the best advantage and support them adequately with capable technicians, there would not be a shortage at all.

One of the necessary steps in this field is similar to the one discussed previously, in that it involves a definite change in attitude on the part of supervisors. The same individual who had trouble thinking in terms of accountants, clerks, etc., instead of an engineering class, in many cases will have somewhat similar trouble in thinking in terms of technicians taking over duties which traditionally have been handled by engineers. And, too, he may find the distinction between technicians and engineers a finer, and so more difficult, one to delineate.

One area where the revision of supervisory attitudes has resulted in a tremendous increase in the use of, well-qualified technicians is in the drafting room. Discarding of prejudices against the use of women and realization of the capabilities possessed by many drafting employees have made possible much better use of sizeable sources of qualified technicians.

Another factor in this problem which is quite important is that the conditions surrounding the employment of technicians must be attractive enough to retain them in the field. This means that the work must be interesting and challenging and the pay high enough to compete with other fields requiring about the same amount of training and experience. Also, there must be a definite and obvious pathway leading to a satisfactory goal.

Recent analysis of the organizational structure described at the beginning of this article indicated that it was somewhat deficient in its appeal to the type of technician needed to supplement our professional nucleus. A large number of people were progressing to the Assistant Highway Engineer level (\$481 to \$581 a month at present). Because of their capabilities and experience, a considerable number of these employees then were being used as resident engineers or design squad bosses (ordinarily Associate level positions) because of a shortage of registered Associate Highway Engineers. In effect, we had a considerable number of highly-trained and experienced technicians who could and were handling many Associate level assignments but were receiving Assistant pay.

Farther down the ladder, at the Junior Civil Engineer level, a somewhat similar situation existed. This class was made up of two different types, the first of which had had no college training at all and considerable experience in the Aid classes, while the second had had no experience at all but had completed an accredited civil engineering college course. All these employees were required to pass an academic examination on engineering fundamentals in order to become Junior Civil Engineers. One result was that many of the first type were having difficulty in passing the examination, and turnover figures were quite high.

To alleviate these conditions and try to make the technicians' path more realistic and attractive, it was decided to establish two new classes, in cooperation with the State Personnel Board. The first, labeled "Highway Engineering Technician," roughly parallels the class of Junior Civil Engineer (having a salary range of \$415-505 as compared with \$436-481). The people taking the examination for this class will be examined on experience rather

than on academic fundamentals. The other class, which was actually reactivated rather than newly-established, is called "Highway Engineering Associate" and presently carries a salary range of \$556-676, one pay step less than the \$584-710 presently paid to the registered Associate Highway Engineer. Here again the required civil service examination is of an experience type. A glance at Figure 1 will indicate the relative features of the old and the new organization structures.

One other important element in this phase of the problem which must be kept in mind at all times is that if recruitment of new material is to be successful, the organizational pattern must have a realistic relationship to current educational practices in the vicinity of the employing unit. Analysis of the three-level aid structure indicated that it had become "out of tune" with practices of other employers in the field. Educational requirements for the various grades (with no supplementing experience) were: Under Aid—completion of eleventh grade; Junior Aid—completion of one year of college engineering; Senior Aid—completion of three years of college engineering. Since the most common breaking point for college careers, particularly in California with its many junior colleges, was at the end of the second year rather than the first or third, some prospective recruits were complaining that proper credit was not being given for part of their education.

To correct this situation, again in cooperation with the State Personnel Board, the three Aid classes were eliminated and replaced by two new classes, Engineering Aid I and II. The requirements for Aid I were revised to require high school graduation, and two years of college engineering were required for Engineering Aid II. Revision of the minimum qualifications for these grades is making it possible to coordinate our recruiting efforts much more closely with the various educational institutions which are presenting two-year engineering curricula of either a terminal or a pre-professional type.

Possibly some of the best examples of the effective use of a combination of professional engineering talent and other supporting classes are the recent developments in the fields of photogrammetry and electronic computing as applied to the practice of highway engineering. Progress is so rapid it is difficult to keep abreast of the latest developments, but already in California we are doing most of our earthwork computations and traverse calculations with the electronic computer, and are continually increasing our use of photogrammetric methods in planning and design. In both of these fields there is a very close relationship between those handling the engineering phases and those responsible for the technical phases. And of course the extreme labor-saving nature of the processes has made possible the wider spreading of both engineering and engineering technician talents.

Summarizing, it can be said that proper use of engineering talent, adequately supported by engineering technicians, appears to be the only solution to the current engineering shortage in the highway engineering field. This will require constant attention on the part of those administering engineering personnel programs and, in the cases of governmental units, intelligent and reasonably flexible administration of the civil service regulations which apply.

# ENGINEERING ORGANIZATION STRUCTURES

California Division of Highways  
1956

## Original Organizational Structure

ASSOC. HWY. ENGR.  
(584 - 710)

College Grad. or Equiv.

+

2 yrs. Highway Engrg.  
at Assistant Level

+

Registr. as Civil Engr.

ASST. HWY. ENGR.  
(481 - 584)

College Grad. or Equiv.

+

1 yr. Jr. Civ. Engr. or  
2 yrs. Engr. Exp. at  
Jr. Civ. Level

JR. CIVIL ENGR.  
(436 - 481)

College Grad. or H.S.  
+ 2 yrs. Civ. Engr. Exp.

SR. ENGR. AID  
(358 - 436)

3 yrs. College Engr. or  
H.S. + 18 mos. Exp.

UNDER ENGR. AID  
(281 - 341)

Completion of 11th Gr

HWY. ENGR. ASSOC.  
(556 - 676)

5 yrs. Hwy. Engr.  
(2 yrs. at Asst. Level)

HWY. ENGR. TECH.  
(415 - 505)

2 yrs. Engr. Aid II or  
H.S. Grad. + 3 yrs.  
Subprof. Engr.  
(2 yrs. Hwy.)

JR. ENGR. AID  
(325 - 395)

1 yr. College Engr. or  
H.S. + 6 mos. Exp.

## Revised Organizational Structure

ASSOC. HWY. ENGR.  
(584 - 710)

College Grad. or Equiv.

+

2 yrs. Highway Engrg.  
at Assistant Level

+

Registr. as Civil Engr.

ASST. HWY. ENGR.  
(481 - 584)

College Grad. or Equiv.

+

1 yr. Jr. Civ. Engr. or  
2 yrs. Engr. Exp. at  
Jr. Civ. Level

JR. CIVIL ENGR.  
(436 - 481)

College Grad. Only

ENGR. AID II  
(358 - 436)

2 yrs. College Engr. or  
H.S. Grad. + 1 yr. Exp.

ENGR. AID I  
(281 - 341)

High School Graduate

FIG. 1.



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Journal of the  
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MANPOWER PROBLEMS IN THE HIGHWAY PROGRAM<sup>a</sup>

C. E. Fritts,<sup>1</sup> M. ASCE  
(Proc. Paper 1256)

The highway agencies of the nation are now at the point of actual production of modern highways at a greatly accelerated rate. No longer can these agencies view, with alarm, their ability to meet the engineering portion of the task. The work has been authorized and it is now squarely up to the engineers to face the realities of accomplishment.

It has been said that a project of the magnitude of the current National Highway Program is, in itself, the greatest magnet to attract engineers. And certainly the challenge and opportunity that is afforded by the greatest public works program in world history will cause many engineers to consider taking part. But in spite of the great challenge to engineers which comes from this program, the job will not be accomplished through that one appeal.

There are certain fundamental facts which minimize the probability of early migration of engineering talent in sufficient numbers to the highway field.

In the first place, it should be recognized that engineering services of all kinds assume an ever increasing role of importance in the nation's production. We are in an age of technological production. The burden of continually expanding our Gross National Product in a large measure falls upon scientists and engineers of all categories. This is illustrated by the fact that in 1900 the number of engineers per 10,000 population was five. In 1956 the ratio had changed to 42 engineers for every 10,000 persons. Thus, meeting the needs for engineering service for one phase of production, such as highways, must be done in competition with the needs in many other areas.

Today, there is an insufficient supply of qualified manpower in numerous areas. Some indication of the shortage of engineering service of all types is obtained from an estimate made by Northwestern University. A report by Frank S. Endicott, Director of Placement, says "Reporting companies will seek 47 percent more technical men than they hired last year, an increase due in part to the increasing backlog of unfilled needs from previous years." Not only do we have a shortage now, but at current rates of graduation in science and engineering, we will be short by 100,000 in ten years. This is based on the assumption that the percentage of college graduates in science

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a. Jackson Meeting, Highway Division, ASCE, February 20, 1957.

1. Vice Pres., Automotive Safety Foundation, Washington, D. C.

and engineering remains constant. It does anticipate greater total enrollment as population increases.

Highway agencies are starting the enlarged roads program under handicap of a backlog shortage of qualified engineers. If that handicap is to be successfully overcome, many historical and current actions must be altered or expanded.

There are no figures precise enough to give an exact evaluation of the backlog of needs in highway engineering manpower. The entire group of agencies—Federal, State, City, and County—have not been surveyed. However, in a major sector, the State Highway Departments, we find a positive indication of the range of need. About 21,000 engineers are employed in State Highway Departments. In 1956, these Departments indicated the need for 4,465 more engineers. In other words, they are handicapped by a personnel shortage of about 20 percent. Further, this survey was made before the National Highway Program had become a reality. As the program advances, the need will increase unless offsetting action meets the problem.

Recent lack of progress in overcoming the indicated shortage is illustrated by Highway Department records of employment and losses of personnel. During 1955, the Departments employed or promoted to professional grades 2,734 engineers. In the same period they lost 2,164 by deaths, retirements, separations or resignations. The net gain was 560—in contrast to the need of 4,465.

If the personnel needs of other highway agencies were added to the state figures, the number obviously would be much greater. Needs of the states alone, give ample evidence of the necessity for considering every means of meeting the problem. Courses of indicated action are both short and long range in character. Let us now turn to a discussion of some facets of the action program.

A fundamental first requirement is a program of engineering education which not only produces qualified, professionally trained engineers, but also does so in sufficient numbers. Only by increasing the number of engineering graduates attracted to highway specialization, can the backlog eventually be overcome. This requires, in the first instance, creation of an increased desire by high school graduates to enter the engineering schools of our colleges and universities.

While college enrollment continues to increase gradually, there has been no significant rise in the percentage of total enrollment studying engineering. Currently, about 7 1/2 percent of the entering students choose one of the major branches of engineering. And of 22,000 graduates in engineering, only about 4,000 are civils—the major source of technical skills for highways. A survey of recent years shows that about 550 civil graduates go to work for State Highway Departments. That number may be somewhat greater now, but it must be greatly increased to overcome present shortages of more than 4,000 in highway departments alone.

The steps to be taken are obvious. In addition to increasing the percentage of students taking engineering, a greater number must be encouraged to take highway specialization in the civil branch. This, of course, has to be viewed as a long term solution because it takes time for the education process to produce. Also, it takes further time for graduates to gain needed in-service training and experience.

To meet long-term requirements as well as immediate necessities, forward-looking Departments are moving on many fronts. Management policy

is being revised and reorganizations are taking place. Alert administrators are giving far more attention to the manpower problem. These effective actions by personnel management are bound to achieve an increased interest. This interest will stimulate graduates as well as other qualified personnel not now in the highway field.

Now, let us turn to a discussion of some of the actions that can be taken to meet the problem.

One of the first steps is in revision of the organization charts. Such revisions must recognize the increased magnitude of the job ahead and the new balance of work load as it affects functions of the departments and as it reshapes the program on a geographical basis. It is obvious that the planning, design and construction functions must be geared to a greatly increased work load. The organization chart must reflect this new balance of functions. Another consideration is that in most states a greatly increased emphasis must be placed on urban facilities. Such facilities require comprehensive planning and complex designs which are out of proportion to past experience. In some cases this later phase of the program may require a brand new function to be added to the organization chart.

The organization chart and the definition of responsibilities must be defined clearly. Waste of talent through misplacement or duplication must be avoided. Engineering capability must be used to the maximum; not dispersed on functions which can be performed by other personnel properly qualified and trained for non-engineering activities. Departments which have undergone such reorganization and analysis are showing real results in terms of accomplishment per employee. Also, morale is high.

Along with reorganization, steps must be taken to place the organization in a competitive position with industry and other agencies for needed engineering service. This involves not only salaries, but other incentives.

### Salaries

In comparison with other fields of engineering, low salaries characterize the highway engineering profession. While many highway agencies have made progress in recent years towards putting salaries of highway engineers on a competitive basis, much still remains to be done.

In 1955 the American Society of Civil Engineers conducted a nationwide survey of the salaries for civil engineering positions of all types, including highway. The study covered both private and public organizations. Results were summarized by type of employment. Private organizations were grouped into three broad fields: (1) consulting firms, (2) construction firms, and (3) railroads, utilities and industries. Public organizations were grouped by (1) state highway departments, (2) municipalities and counties, and (3) Federal agencies.

A comparison of engineering salaries reported by 38 state highway departments with those listed by 34 private construction firms is shown in Table I. In the lower grades, salaries of highway engineers average about 12 percent less than those of engineers employed by private construction firms. For the more experienced engineers, the differential is more pronounced, ranging up to 42 percent in the top grade.

A similar comparison of engineering salaries in 38 state highway departments with those given by 29 railroads, utilities and industries is shown in Table II. In this case the differential is about the same in the lower grades but ranges up to 60 percent in the topmost grade.

This relationship of lower salaries for engineers in public organizations, be they state, municipal, county or Federal, is borne out in all comparisons with the average engineering salaries reported by the various groupings of private organizations. The relationship varies only as to degree.

Not only are average salaries reported by public organizations consistently below salaries of engineers employed by private firms, but the range between the bottom and topmost grades is much more restricted. The average salary for the top grade reported by the 38 State Highway Departments is 2.75 times the average salary reported for the lowest grade. For private construction firms the average salary reported for the top grade is 3.48 times the average salary of the lowest grade, and for railroads, utilities and industries this relationship increases to 3.88.

The limited opportunity for advancement over the years discourages many new graduates from entering the highway engineering field and contributes to the loss of experienced engineers to private employment. Today a young engineer's choice of employment depends as much on what salary he can expect throughout his years of continuous service as it does on the starting salary.

### Incentives

Salary alone, even when on a fully competitive basis, is not the sole criterion for solution of the highway engineering manpower problem. To attract and hold engineering talent several other basic requirements must be met. Recruitment of new engineering graduates today is highly competitive. The demand greatly exceeds the supply. Senior students are being offered numerous job opportunities. The competition is so great that many schools have found it necessary to restrict the number of interviews both on the part of the students and the prospective employers.

Because of these highly competitive conditions, private organizations have found it necessary to include additional inducements, over the above salary offers, to secure needed personnel.

Principal among these added inducements offered by private organizations are:

- Stability of advancement
- Professional recognition
- Working conditions
- Nature and location of work
- Overtime pay
- Liberal sick leave and vacation privileges
- Retirement and other benefits
- Recreational facilities and programs
- Stock bonus or profit sharing plans

The last of the above listed inducements, and to some extent the next to last also, are peculiar to profit-making organizations. As such, they are not applicable to public highway agencies but the remainder are. Highway agencies must adopt the principal of the "attractive package" developed by private organizations, else their chances of securing their minimum requirements in the recruitment of new graduate engineers will be slim indeed.

Most important of these incentive factors would appear to be stability of advancement and professional recognition. To attract, and retain, engineering talent there must be positive evidence that careers are not subject to the

whims of political manipulation—that opportunity to move upward in the organization is based on merit and ability. The young graduate engineer should have assurance of moving ahead consistent with his individual development of the confidence and abilities to assume increased responsibilities. The time-worn and traditional concept of many public agencies that opportunity for advancement should be measured by length of service should be discarded in favor of periodic and systematic performance appraisals designed for the purpose of rewarding capabilities.

Professional recognition is an important prestige consideration. All states now have registration laws for professional engineers in private practice. Public agencies should encourage and give due recognition to registered professional engineers in public employment. At present only a few State Highway Departments recognize registration as a qualification for advancement to the middle and top engineering grades.

In addition, membership in professional societies and participation in technical, civic and cultural activities should be encouraged. This results both in professional growth on the part of the engineer and public relation benefits to the highway agency.

Private organizations today, be they large or small, almost universally provide fringe benefits to employees in the form of overtime pay, retirement plans, sick leave and vacation privileges, group hospitalization, life insurance, and other similar features. These benefits represent extra income and security for emergencies.

There appear to be no recent nationwide comprehensive surveys of benefits and incentives for professional employees of State Highway Departments and those in private employment. A limited comparison has been made of several benefit and incentive factors based upon information obtained from voluntary response to questionnaires sent to all State Highway Departments and to a number of consulting engineers throughout the country engaged in highway practice. Those responses show the normal work week for most consulting engineering firms is 40 hours. This is also true for most State Highway Departments. However, three Departments report work weeks of 44 hours and one lists 48 hours as the week for field employees. Practically all consultants pay for overtime on the basis of time and one half. Most highway departments do not compensate for overtime work but allow compensatory time off in slack seasons. Of those departments that do pay for overtime work, only three report doing so on the basis of time and one half. Eighteen others pay for overtime on a straight time basis but in many cases this provision applies only for lower grade employees or has a maximum monthly limitation.

Consultants report paid vacations of generally two or three weeks after five years of service. This corresponds closely with the practices of the State Highway Departments. With respect to sick leave privileges, the policies in private employment allow 10 to 15 days for routine illnesses. In the case of serious illness or in hardship cases there frequently is no limit on the amount of time allowed with full compensation. Most states grant 12 to 15 days of sick leave per year. However, many of them have provision for accumulation of unused sick leave with maximums of up to 60 days and higher, which tends to meet the unlimited leave practices of consultants in hardship or serious illness cases.

Two-thirds of the consultants report life insurance plans in effect. The amount carried for each individual ranges from a minimum of \$2,000 to a

maximum of \$32,000, depending on salary. In all cases entire cost of the insurance plan was paid by the employer. No highway department has a comparable plan where the cost is paid entirely by the state. Five states report life insurance plans giving a maximum of \$5,000 coverage per employee and with from 20 percent to 60 percent of the cost paid by the state. Seven other states list life insurance provisions as a part of state retirement plan. A number of other states sponsor, endorse, or make provision for pay roll reductions for group life insurance plans but in those cases, 100 percent of the cost is paid by the employer.

About 80 percent of the consultants responding to the questionnaire advise they have employee hospitalization or health insurance programs. In half of these programs the entire cost is paid by the employer. In the others, employee contribution runs from 50 to 100 percent. No highway department reported a state-sponsored hospitalization or health insurance plan paid for entirely by the state. Three states have plans involving employee contribution from 50 to 80 percent of cost. A number of other states sponsor, endorse, or permit pay roll deductions for group hospitalization plans where the cost is paid entirely by the employee.

These comparisons should be considered as illustrative of the differences between public and private employment; not as necessarily representing average conditions on a nationwide basis.

Benefits and incentives provided by most highway departments fall short of the level attained by private organizations. The engineer in public employment has the same socio-economic problems as an engineer in private employment. As such, he is entitled to, and should have, working conditions and benefits fully comparable with those offered by private organizations.

In conclusion, it should be noted that this paper is not intended to be an all-inclusive discussion of the highway manpower problems. Several other facets of the problem are deserving of great consideration. For example, a necessity of active and forceful recruitment; in-service training programs for all personnel; the need to develop a supply of specialized engineering technicians to support work of the fully qualified engineer; the need for further development of mechanical devices, such as photogrammetry and electronic computation to save both manpower and time. Greater effort is needed also to insure an adequate and competent core of engineering instructors and to provide courses in Junior Colleges and Trade Schools to teach engineering technicians. All of these related subjects are of sufficient importance as to warrant separate discussions of each.

There can be no doubt about the ability of the profession to meet the engineering need for the highway program of the present and of the long-range future. This can be done if everyone concerned will recognize the necessity for giving the manpower problem the attention it deserves.

TABLE I

Professional Engineering Grade	Average* Annual Salaries Reported by	
	38 State Highway Departments	34 Private Construction Firms
1	\$ 4130	\$ 4605
2	4595	5310
3	5455	6010
4	6150	7095
5	6750	7880
6	7800	8740
7	8705	9865
8	9665	12385
9	11320	16020

\*Average of Entrance and Maximum Medians

Source: Survey of Salaries for Civil Engineering Positions  
American Society of Civil Engineers August 1955

TABLE II

Professional Engineering Grade	Average* Annual Salaries Reported by	
	38 State Highway Departments	29 Railroads, Utilities and Industries
1	\$ 4130	\$ 4680
2	4595	5235
3	5455	6015
4	6150	7285
5	6750	8095
6	7800	9710
7	8705	10840
8	9665	12410
9	11320	18190

\*Average of Entrance and Maximum Medians

Source: Survey of Salaries for Civil Engineering Positions  
American Society of Civil Engineers August 1955



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Discussion of  
 "THE HIGHWAY SPIRAL AS A CENTERLINE FOR STRUCTURES"

by Paul Hartman  
 (Proc. Paper 1090)

A. H. BROWNFIELD,<sup>1</sup> A.M. ASCE.—This paper like its predecessor (703 June 1955) is informative and represents considerable time and effort by the author. The author has indicated one solution to an interesting problem but this may not appeal to all who read it. With this in mind the writer will submit in outline form two other methods for computing alignment data for structures, based on previously published data. The writer sees no reason for perpetuating the degree system of nomenclature for Highway work and except for one school course in Railroad Surveying, he has had little use for it. Most of our studies in school mathematics and surveying dealt with curves and their radii. This, as an addenda to the author's paper, will follow his notation and will introduce new nomenclature as it occurs. As a side issue the writer has found the Euler Spiral (Highway Spiral) a convenient means for approximating the curve of a continuous strand in prestressed concrete flat lift slabs. Only one or two terms of the series are needed and by using the same  $\theta$  value for all parts of the strand in any span the curve is relatively simple. The strand was assumed as reversing at the outer 1/6th points.

In paper No. 2288 (Trans., Vol III, 1946, pp. 986) the writer referred to  $R_c = \frac{R_1 R_2}{R_1 + R_2}$  where  $R_1$  and  $R_2$  are the terminal radii of any portion of the spiral arc. Also  $\theta_c = \theta_1 - \theta_2$  the angle between the two radii  $R_1$  and  $R_2$ . Then

$$\ell_c = \ell_1 - \ell_2 = 2R_c \theta_c \quad (18)$$

This is an exact equation. The short chord slope and the  $\theta$  value of the normal to it can be approximated by

$$\alpha_c \approx (\theta_1 + \sqrt{\theta_1 \theta_2 + \theta_2}) \div 3 \quad (19)$$

The chord length is

$$C_c \approx 4R_c \sin \theta_c \quad (20)$$

It should be evident that the foregoing equations can be used directly to locate points with reasonable accuracy along the spiral and parallel to it. This was the basic reason for publishing them. Their correctness will be demonstrated by the author's numerical example.

1. Superv. Structural Engr., State Div. of Architecture, Sacramento, Calif.

## Point C

$$\begin{aligned}\ell_2 &= 320' \\ R_2 &= 4^\circ = 1432.394' \\ \theta_2 &= 6.4^\circ \\ x_2 &= 319.601' \\ y_2 &= 11.904'\end{aligned}$$

## Point D

$$\begin{aligned}\ell_1 &= 360' \\ R_1 &= 4.5^\circ = 1273.240' \\ \theta_1 &= 8.1^\circ \\ x_1 &= 359.281' \\ y_1 &= 16.940'\end{aligned}$$

$$2R_c = 4.25^\circ = 1348.136' \quad \theta_c = 1.7^\circ \quad 2R_c \theta_c = 40.000'$$

The chord  $\div 2 = C_c/2 = 2R_c \sin \theta_c/2 = 19.999'$  and the normal to this chord has a length of  $\sqrt{1348.136^2 - 19.999^2} = 1347.988'$ . The chord slope  $\alpha_c$  or  $\theta$

for the normal  $= (6.4^\circ + 7.2^\circ + 8.1^\circ) \div 3 = 7.2333^\circ$  where  $7.2^\circ = \sqrt{6.4 \times 8.1}$ .

The coordinates for the midpoint of the chord are  $(x_1 + x_2) \div 2 = 339.441$  and  $(y_1 + y_2) \div 2 = 14.422$ .

Point A of Fig. 1

$$\ell_c = 340' \text{ Reference point for circle.}$$

$$2R_c = 1348.136$$

$$\theta = 7.2333^\circ$$

$$\text{Normal} = 1347.988$$

$$\text{Sin.} 1259104 \quad x = 169.726$$

$$\text{Center Coordinates } X_A = 169.715$$

$$\text{Cos.} 9920416 \quad y = 1337.260$$

$$Y_A = 1351.682$$

Note  $\div$  This point A is not on the involute—but close to it.

The radial distance to point F Fig. 1 is  $1348.136 + 36.000 = 1384.136$ . Now solving the authors triangle A.G.F. with sides  $1384.136'$  and  $1365.290'$  along with angle  $G = 8.09635^\circ + 45^\circ = 53.09635^\circ$  we obtain for  $AF$   $\theta = 7.06965^\circ$ . Now our reference point was the normal with  $\ell_c = 340$  and  $\theta = 7.2333^\circ$ . Correcting back  $H = \text{Sta. } 336.149'$  (correct =  $336.154'$ ) The error being relatively small. The correction was  $2R_c$  times the change in  $\theta$ .

A third solution that should not be omitted in a paper of this type, is based on the use of available tables. Assume the computer can plot Fig. 1 and estimates by using a slide rule that  $\theta_{AF} = 7.05^\circ = \theta_1$ , the reference point is #8 or point C with coordinates listed above.

$$\begin{aligned}\text{Now } \ell_1 &= \ell_2 \sqrt{\frac{\theta_1}{\theta_2}} = 320 \sqrt{\frac{7.05}{6.4}} = 335.857 \\ R_1 &= 1364.765 \\ \theta_1 &= 7.05^\circ \\ x_1 &= 335.349' \\ y_1 &= 13.760'\end{aligned}$$

The trial coordinate of G is  $x = 361.734$  (362 given)

$$\text{error} = 0.266'$$

Now we can plot a figure for point F. See Fig. 4.

$$\ell_1 + \Delta \ell = 335.857 + 0.298 = 336.155' \quad \text{Correct} \quad (336.154')$$

A second trial similar to the above will yield the correct station of 336.154 which is unnecessary.

The material in this discussion was assembled on the assumption that the reader was familiar with the authors paper 1090, with basic trigonometry and has a working knowledge of spirals. The computer should assemble good tables by reviewing paper No. 2286 and its extensive bibliography. He should also review the literature published since that date. The writer has shown



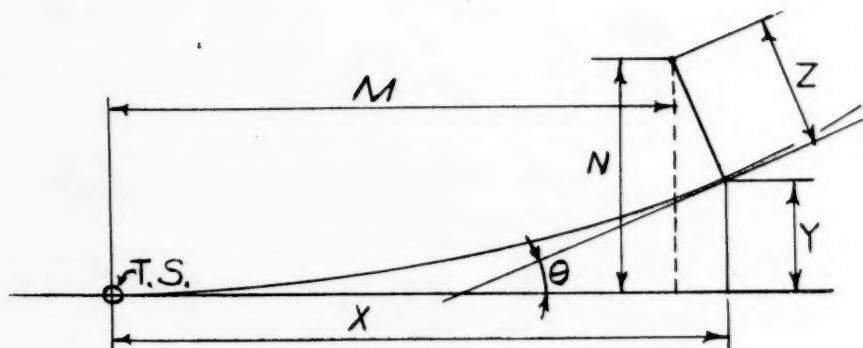


Fig. #1.

Using the tangent extended from the T.S. as the x distance and the normal to that tangent as the y distance. It is desired to know the elevation on the pavement above a stringer bearing located at M & N distance from the T.S. (see Fig. #1). The problem is to find the station (L) to which a normal to the spiral curve at that station would pass through the point M & N.

Substituting the basic equations and setting the equation equal to zero we have:

$$N \tan \frac{\theta_s L^2}{L_s^2} - L \left[ \frac{\theta_s L^2}{3 L_s^2} - \frac{\theta_s L^5}{42 L_s^5} + \dots \right] \tan \frac{\theta_s L^2}{L_s^2} + M - L \left[ 1 - \frac{\theta_s L^2}{10 L_s^2} + \frac{\theta_s L^6}{216 L_s^6} - \dots \right] = 0$$

The above equation has one unknown L. But it is a laborious task to solve unless there is an electric brain available.

The general equation IV may be solved by use of Tables (References 1 & 2). Assume L, some length longer than M by inspection. Find  $\theta$  by use of basic equation I. Find x and y from table; then check the assumption of L and correct L accordingly. The first assumption for L may be done on the slide rule. The final assumption for L should be checked more accurately than the slide rule.

Example:

If  $\theta = 8^\circ$ ,  $L_s = 400'$ ,  $M = 200'$ ,  $N = 30'$  See Fig. # 1.

Assume  $L = 210$

$$\theta = L^2 \frac{\theta_s}{L_s^2} = 210^2 (.00005) = 2.205$$

From table (reference # 2.)

x coef. = .0128009      y coef. = .999853

y = L(y coef.) = 210(.0128009) = 2.688

x = L(x coef.) = 210(.999853) = 209.97

(N-y) Tan.  $\theta = x - M$

(30-2.688) (.0384) = 209.97-200

10.48  $\neq$  9.97, therefore L assumed is in error.

The error in  $L$  assumed is approximately the difference between 10.48 and 9.97.

Therefore assume  $L = 210.59$

$$\theta = 2.2174^\circ$$

$$x = 210.59(.999851) = 210.5586$$

$$y = 210.59(.012899) = 2.7164$$

$$(N-y) \tan \theta = x - M$$

$$(30 - 27164) (.038722007) = 210.5586 - 2000$$

$$10.5648 \neq 10.5586$$

$L = 210.597$ . If a greater degree of exactness than this is required it may be obtained.

The distance  $Z$  from the point (M.&N.) to the spiral is needed for the superelevation.

$$Z = (N-y) \sec \theta$$

V

The signs in the general equation (IV) will change if the point (M.&N.) is located on the other side of the spiral (Equation VI) or between the spiral and the tangent. (Equation VII).

$$(N+y) \tan \theta = M - x$$

$$Z = (N+y) \sec \theta$$

VI

$$(y-N) \tan \theta = M - x$$

$$Z = (y-N) \sec \theta$$

VII

If a bridge has a group of stringers uniformly spaced under a spiral curved highway, the first assumption for  $L$  for a stringer can be made with a greater degree of accuracy after three stringers have been calculated. There exists a relationship between them, that is; the second difference between  $L$ 's can, for practical purposes, be called a constant within small ranges. After finding this second difference, the assumed  $L$  for any succeeding stringer may be made by adding to the previous  $L$  the first difference and subtracting the second difference (see Fig. #2. & Table A.).

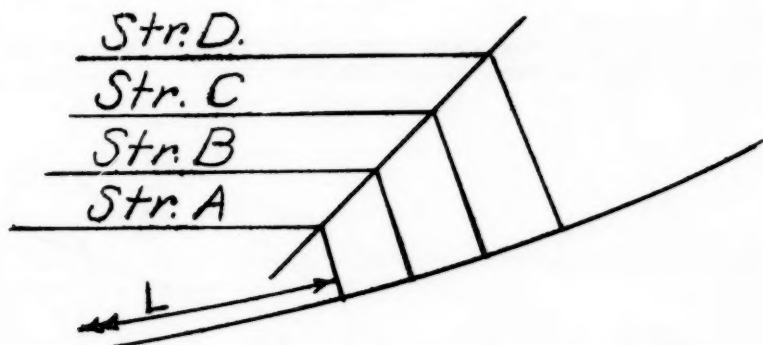


Fig. 2.

	L	1st diff.	2nd diff.
Str. A	161.64	4.96	.06
Str. B	166.60	4.90	
Str. C	171.50		

Table A.

Assume L for stringer D is  $171.50 - 4.90 - .06 = 176.34$

The intersection of a line with a spiral may be solved in a similar manner.  
(See Fig. # 3.)

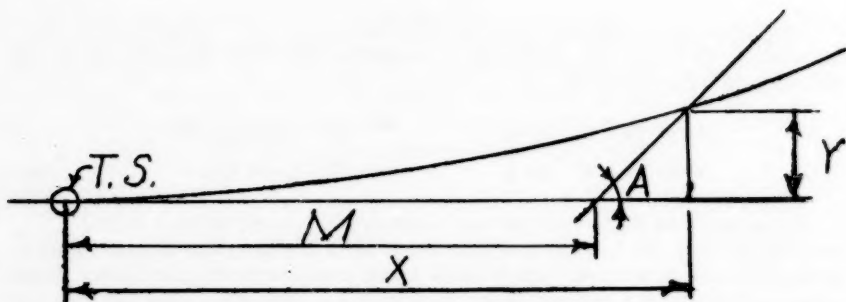


Fig. 3.

$$x - M = y \tan A$$

VIII

Assume L as before.

The intersection of a concentric spiral (face of Parapet) and a line may be solved in a similar manner also. (See Fig. # 4)

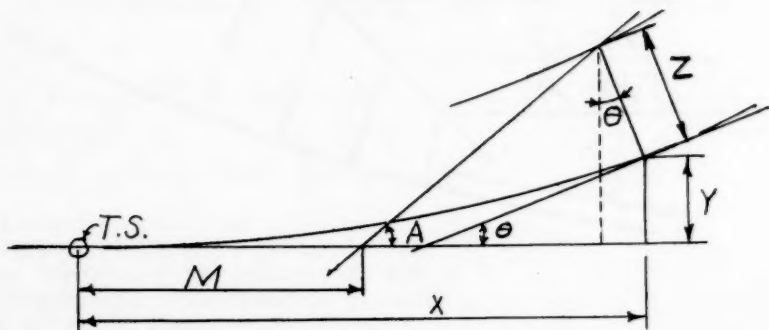


Fig. 4.

$$M + (y + Z \sec. \theta) \cot. A = x - Z \csc. \theta$$

IX.

Assume L as before.

A chord to a spiral may be useful in determining the direction of the stringer should take under the spiral curved highway. The offset from the chord would be useful to determine the maximum overhang from the stringer to the face of the Parapet. The direction of the chord with relation to the tangent may be determined as shown in Fig. # 5.

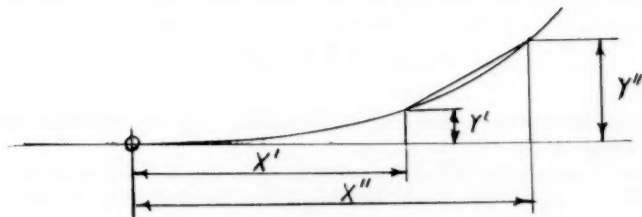


Fig. 5.

The offset may be determined by extending the chord and determining the spiral angle  $\theta$  (Fig. #6.). Knowing the spiral angle  $\theta$ ,  $y'''$  may be determined by use of the tables. The offset may be determined by equation X.

$$(x''' - y''' \cot. \theta) - (x' - y' \cot. \theta) \sin. \theta = \text{offset} \quad \text{X.}$$

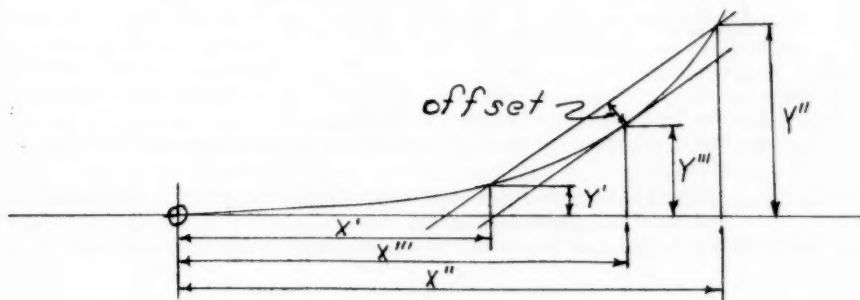


Fig. 6.

The chord and the offset for a concentric spiral (Face of the Parapet may be determined by use of Equations IX and X.

## REFERENCES

1. Transition Curves for Highways by Joseph Barnett, Public Roads Administration, U. S. Government Printing Office, Washington, 1940. Table #II.
2. Standard Highway Spiral by H. W. Libby, Oregon State Highway Commission, Salem. Table # IV.

ANGEL PICCIO VILLASOR, JR.,<sup>1</sup> J.M. ASCE.—Consider the locus of points at a distance  $D$ , outward from the spiral centerline. It is seen that the  $Y$ -coordinates of these points are in the region:

$$(Y_s - D \cos \theta_s) \geq Y \geq -D \quad (1)$$

where  $Y_s$  = the  $Y$ -coordinate of the spiral at S.C.

and  $\theta_s$  = the total spiral angle

The illustrative problem gives  $D = 36'$ ,  $\theta_s = 50^\circ$ , and  $L_s = 400'$ . Then Eq. 1 becomes

$$-24.235 \geq Y \geq -36.000 \quad (1A)$$

If the station of column F must fall on the spiral, its  $Y$ -coordinate certainly cannot be equal to  $-21.931$ , as given.

A general equation covering the present case has already been derived.<sup>2</sup> For  $\theta_s = 50^\circ$  and  $L_s = 400'$ , it can be shown that the following is sufficiently accurate:

$$\begin{aligned} & \frac{\theta_s^5 D}{(5!) L_s} L^{10} + \frac{\theta_s^4 D}{9(4!)} L^9 + \frac{\theta_s^4 D \cot \alpha}{(4!) L_s} L^8 + \frac{\theta_s^3 \cot \alpha}{7(3!)} L^7 \\ & - \frac{\theta_s^3 D}{(3!) L_s} L^6 - \frac{\theta_s^2 D}{5(2!)} L^5 - \frac{\theta_s^2 D \cot \alpha}{(2!) L_s} L^4 - \frac{\theta_s \cot \alpha}{3} L^3 \\ & + \frac{\theta_s D}{L_s} L^2 + L + \frac{D \cot \alpha}{L_s} - \frac{A}{L_s} = 0 \end{aligned} \quad (2)$$

where  $A$  = the  $X$ -intercept of the pier centerline

$\alpha$  = the skew angle of the pier, measured counterclockwise from the  $X$ -axis

$L$  = ratio of the spiral length corresponding to the point to be located and the total spiral length,  $L_s$

Substituting in Eq. 2 of the values in the example yields the following:

$$\begin{aligned} & 0.0000000038 L^{10} + 0.0000002685 L^9 + 0.0000002175 L^8 \\ & + 0.0000158231 L^7 - 0.0000099686 L^6 - 0.0007615436 L^5 \\ & - 0.0003426946 L^4 - 0.0290888209 L^3 + 0.0078539816 L^2 \\ & + L - 0.815 = 0 \end{aligned} \quad (2A)$$

1. Formerly Fulbright Scholar and Research Asst., Cornell Univ., Ithaca, N. Y.; Structural Engr., Green Associates, Inc., Baltimore, Md.
2. "Computing Stations for Skew Bridges on Spiral Transition" by Angel P. Villasor, Jr., Unpublished.

By Newton's Method,  $L = 0.8265110828$ . Therefore, the partial length of the spiral corresponding to point F is 330.6044 ft. This is also the station difference between point F and S.T. The spiral angle at the station for F is  $30^\circ 24' 56.17''$ , while the Y-coordinate of the spiral is 6.56927424 ft. The Y-coordinate of the point F is found by means of the relation:  $Y = D \cos \theta$ , which gives  $6.56927424 - 36 \times 0.9982236407$  or  $-29.36677683'$ . It will be observed that this value is within the limits set forth in Eq. 1A. Since  $\alpha = +45^\circ$ , the X-coordinate of point F is simply  $362.00 - 29.36677683$  or  $+332.63322317'$ .

To take care of the situation when the coordinates of the point F( $X_o$ ,  $Y_o$ ) are explicitly given, another general equation has also been derived.<sup>3</sup> A portion of this equation is presented as follows:

$$\begin{aligned} \frac{139}{1512} \theta_s^4 L^9 + \frac{7}{30} \theta_s^2 L^5 + L - \frac{X_o}{L_s} \\ = \frac{Y_o}{L_s} (\theta_s L^2 + \frac{1}{3} \theta_s^3 L^6 + \frac{2}{15} \theta_s^5 L^{10}) \end{aligned} \quad (3)$$

Eq. 3 provides a check for the answers obtained by Eq. 2.

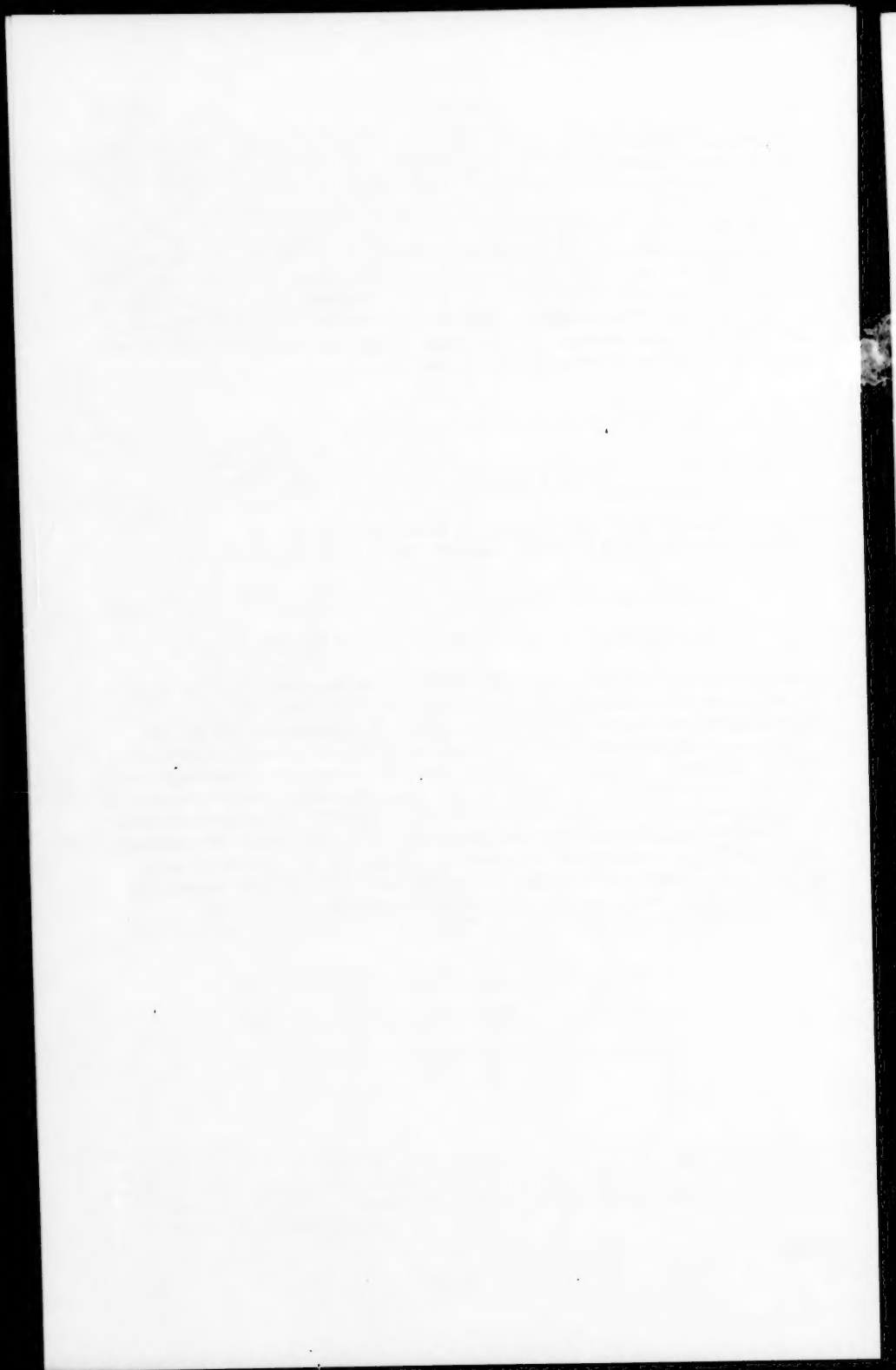
With the proper data from the example, there is obtained by Eq. 3:

$$\begin{aligned} 0.0000000495 L^{10} + 0.0000053315 L^9 + 0.0000162636 L^6 \\ + 0.0017769349 L^5 + 0.0064068368 L^2 + L - 0.831583058 = 0 \end{aligned} \quad (3A)$$

A comparison of the values of the partial spiral length resulting from Eqs. 2A and 3A shows a discrepancy of less than 0.0015 ft. This difference is negligible and serves to confirm the accuracy of computations for Eq. 2A.

The proposed method of Prof. Hartman is ingenious and merits familiarization. It may be pointed out, however, that the arcs of the osculating circles still pose as a substitute for the spiral and thus, the method would not present a truly direct solution to locating points in the geometry of spiral transition. It is further encumbered by the necessary use of special tables. In contrast, Eqs. 2 and 3 are relatively much easier to handle and, in addition to being theoretically correct in relation to the spiral, they automatically determine the profile grade stationing for elevation computations.

3. Ibid.



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## DIVISION ACTIVITIES

### HIGHWAY DIVISION

#### Proceedings of the American Society of Civil Engineers

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#### NEWS

May, 1957

#### HIGHWAY DIVISION EXECUTIVE COMMITTEE

1956 ---- 1957

Professor Harmer E. Davis Institute of Transportation & Traffic Engineering University of California Berkeley 4, California	Chairman	1958
William A. McWilliams 43 E. Division Street Dover, Delaware	Vice Chairman	1959
A. N. Carter Lindsey, Carter & Associates, Inc. Tonka Terrace Shopping Center Excelsior, Minnesota	Member	1960
J. Paul Buckley Automotive Safety Foundation 200 Ring Building 1200 18th Street, N. W. Washington 6, D.C.	Member and Secretary	----
R. Robinson Rowe 2701 Third Avenue Sacramento 18, California	Board Contact Member	1956-1957
Service on Executive Committee will expire in October of year listed opposite name.		
Lowell E. Gregg Assistant Director of Research State Department of Highways 132 Graham Avenue Lexington, Kentucky	Board Contact Member	ASCE Re- search Committee

Note: No. 1957-11 is part of the copyrighted Journal of the Highway Division of the American Society of Civil Engineers, Vol. 83, HW 1, May, 1957.

## HIGHWAY DIVISION

May 15, 1957

Bertram D. Tallamy has resigned from the Executive Committee due to pressure of his activities as Federal Highway Administrator. The Division will greatly miss his active interest and participation in its activities.

It is expected that Mr. Tallamy's replacement will be appointed very soon in order that a full committee will be available for the important work ahead. The new member will be selected from Zone I, since there is now no representation on the committee from that zone.

## JOINT AASHO-ASCE COMMITTEE

Under consideration for some time, a Joint American Association of State Highway Officials-American Society of Civil Engineers Committee is now being organized. This committee, to be composed of ten members, will have Rex M. Whitton, Chief Engineer of the Missouri State Highway Department, as AASHO co-chairman, and Harmer E. Davis, Director of the Transportation and Traffic Engineering Institute of the University of California, as ASCE co-chairman. Other members already appointed include:

## AASHO

C. R. McMillan, Chief Highway Commissioner of the South Carolina State Highway Department

John W. Johnson, Superintendent, New York State Department of Public Works

George T. McCoy, State Highway Engineer of the California Division of Highways

Dwight H. Bray, State Highway Engineer of the Kentucky Department of Highways

## ASCE

William A. McWilliams of DeLeuw, Cather & Brill, New York City

Arch N. Carter, Lindsey, Carter and Associates, Excelsior, Minnesota

J. Paul Buckley, Automotive Safety Foundation, Washington, D. C.

Earle V. Miller, Johannessen, Girand & Miller, Phoenix, Ariz.

## BUFFALO, NEW YORK MEETING

June 3-7, 1957

Edward J. Nunan, Sales Engineer, The Buffalo Slag Company, Inc., is making arrangements for the Highway Division sessions at this meeting. The tentative schedule of speakers and subjects is as follows:

## Monday, June 3, Afternoon Session:

Presiding, Arch N. Carter, Member, A.S.C.E., Member Highway Division, Executive Committee.

The role of the Consulting Engineer in the accelerated Highway Program.  
Speaker - Madigan & Hyland, Consulting Engineers, New York City.

Cooperation with Consultants by Highway Departments and Authorities.  
Conrad H. Lang, Member, A.S.C.E., Chief Engineer, New York State Thruway Authority.

Contractors Organization for large Highway Construction Contracts over \$5,000,000. Howard E. Dixon, Member, A.S.C.E., Vice President, Johnson, Drake & Piper.

Discussion of Basic Tests for Highway Materials.  
Professor Taylor D. Lewis, Cornell University.

Material Quality Control Procedures for Consultants on large Highway Projects. Edward A. Abdun Nur, C. E., Member, A.S.C.E., Consulting Engineer.

**Tuesday, June 4, Morning Session:**

Presiding, J. P. Buckley, Member, A.S.C.E., Secretary  
Executive Committee, Highway Division.

The Federal Aid Highway Program in New York State.  
John W. Johnson, Member, A.S.C.E., Superintendent Public Works, New York State.

Road Development in Ontario. W. J. Fulton, Deputy  
Minister Highways, Province of Ontario.

Metropolitan Traffic and Highway Problems.  
M. V. Jones, Metropolitan Planning Board, Toronto, Ontario.

The Buffalo Thruway & Arterial Plan. E. G. H. Youngmann, District  
Engineer, Buffalo, New York, New York State Department of Public Works.

**Tuesday, June 4, Highway Division Luncheon, 12:15:**

Presiding, E. J. Nunan, Member, A.S.C.E., Chairman  
Highway Division Program for Buffalo Meeting.  
Speaker - B. D. Tallamy, Member, A.S.C.E., Federal  
Highway Administrator.

**Tuesday, June 4, Field Trip, 1:30-5:30 p.m.:**

Buffalo Arterial & Thruway Construction.

**DESIGN STANDARDS FOR THE INTERSTATE HIGHWAY SYSTEM**

It is the strong feeling of the Executive Committee that the design standards prepared by the American Association of State Highway Officials and approved by the Bureau of Public Roads for the National System of Interstate and Defense Highways should receive the endorsement of the Highway Division. The Division's Committee on Geometrics of Highway Design, under the chairmanship of Conrad H. Lang, has completed a review of these standards.

## HIGHWAY DIVISION PAPERS

The Executive Committee is giving serious attention to the problem of production of more papers which are suitable for printing in Society publications. It is hoped that the Committee on Cooperation with Local Sections will be able to create interest in the preparation of additional papers.

Plans are being made to encourage speakers at Society Conventions to prepare papers which not only make good reading but also can readily be summarized for oral presentation.

## FUTURE MEETINGS

Planning is well advanced toward a number of future Society meetings which concern the Highway Division.

Technical Procedures Conference, Oklahoma City, April 12-13, 1957

Messrs. Davis, Buckley and McWilliams will attend this conference, with Professor Davis discussion "Divisions Accept Responsibility for Studying Matters of Public Interest" and Mr. Buckley serving as recorder for the opening session on Friday, April 12. It is hoped that this conference will also provide an opportunity for the advancement of the Division's proposal for publication of a separate Newsletter.

New York Meeting, October 14-18, 1957

Edward S. Olcott, Executive Assistant to the Director of Port Development, The Port of New York Authority, is to serve as the Highway Division's program chairman for this meeting, and already has made great progress toward setting up the Division sessions. Tentatively, the program for Division sessions will be:

Session I - "The Interstate System in Urban Areas is an Administrative Problem for all Levels of Government." Harmer E. Davis presiding. Speakers who have accepted so far are Frank Turner, Bureau of Public Roads; Rex Whitton, Missouri State Highway Department; John B. Benson, Covington, Alabama County Engineer and James E. Lister, Cleveland Planning Director.

Session II - "Current Developments in Metropolitan New York's Arterial System." Edward S. Olcott presiding. Irvin Gould, The Port of New York Authority, and three others, not yet named, will be the speakers at this session.

Session III - "Location and Design Problems in Urban and Rural Areas." William A. McWilliams presiding. Speakers will be J. C. Young of Porter, Urqhart, McCreary & O'Brien; Guy Kelcey and George H. Leland of Edwards, Kelcey and Beck and two others who have not yet been selected.

Session IV - "New Developments in Traffic Engineering." Wilbur Smith of Wilbur Smith and Associates presiding. Speakers will be George Webb, California Division of Highways; Donald McNeil, Consulting Engineer; Richard Strickland of The Port of New York Authority and one other.

### Society Luncheon

The principal Society luncheon at this meeting will have as principal speaker Bertram D. Tallamy, Federal Highway Administrator. For this reason, it is unlikely that the Highway Division will sponsor a luncheon of its own.

### Chicago Meeting, February 24-28, 1958

Jack E. Leisch of the DeLeuw-Cather Company will serve as session program chairman.

### Portland, Oregon Meeting, June 23-27, 1958

G. S. Paxson, Assistant State Highway Engineer at Salem, has been appointed as Highway Division session program chairman for this meeting.

## COMMITTEE ACTIVITIES

### Committee on Cooperation with Local Sections

Chairman S. E. Ridge reports on efforts of this committee to obtain interest in highways among the local sections. As reported above, it is hoped that this activity will produce a greater number of papers suitable for printing in Society publications.

### Committee on Highway Engineering Manpower

Chairman Carl E. Fritts reports that his committee is preparing a brochure on career opportunities in the highway field. It is hoped that high school students and their counselors will be reached through this booklet.

### Committee on Significance of Tests for Highway Materials

A manual "Significance of Tests for Highway Materials: Basic Tests" prepared by this committee has been submitted to the manager of Technical Publications with the recommendation that it be published as a manual of engineering practice.

### Committee on Traffic Engineering

Chairman Wilbur S. Smith plans a meeting of this committee in conjunction with the Annual Meeting in New York in October.

### Committee on Highway Maintenance and Operations

This committee is in the process of organization. Members appointed to date are: Charles M. Noble, Ohio Department of Highways (Chairman); F. M. Davis, Texas Highway Department; Emmett H. Karrer, Ohio State University; Theodore H. Kauer, Holmes Construction Company and Alger F. Malo, Detroit Department of Streets and Traffic.

### Committee on Urban Transportation

An organizational meeting of this committee will be held in the near future.

## COMMITTEE MEMBER HANDBOOK

A committee member handbook has been prepared and distributed to all Division committee members. Secretary J. P. Buckley will welcome helpful comments about this handbook.

Additions to Division committees since the January, 1957 Newsletter listing are:

## Committee on Geometrics of Highway Design

R. E. Livingston  
Planning and Research Engineer  
Department of Highways  
Denver, Colorado

## Committee on Urban Transportation

D. Grant Mickle  
Director, Traffic Engineering Division  
Automotive Safety Foundation  
Washington, D. C.

## Newsletter Editor:

George H. Leland  
Edwards, Kelcey and Beck  
3 William Street  
Newark 2, New Jersey

# PROCEEDINGS PAPERS

The technical papers published in the past year are identified by number below. Technical-division sponsorship is indicated by an abbreviation at the end of each Paper Number, the symbols referring to: Air Transport (AT), City Planning (CP), Construction (CO), Engineering Mechanics (EM), Highway (HW), Hydraulics (HY), Irrigation and Drainage (IR), Pipeline (PL), Power (PO), Sanitary Engineering (SA), Soil Mechanics and Foundations (SM), Structural (ST), Surveying and Mapping (SU), and Waterways and Harbors (WW), divisions. Papers sponsored by the Board of Direction are identified by the symbols (BD). For titles and order coupons, refer to the appropriate issue of "Civil Engineering." Beginning with Volume 82 (January 1956) papers were published in Journals of the various Technical Divisions. To locate papers in the Journals, the symbols after the paper numbers are followed by a numeral designating the issue of a particular Journal in which the paper appeared. For example, Paper 1113 is identified as 1113 (HY6) which indicates that the paper is contained in the sixth issue of the Journal of the Hydraulics Division during 1956.

## VOLUME 82 (1956)

MAY: 961(IR2), 962(IR2), 963(CP2), 964(CP2), 965(WW3), 966(WW3), 967(WW3), 968(WW3), 969(WW3), 970(ST3), 971(ST3), 972(ST3)<sup>c</sup>, 973(ST3), 974(ST3), 975(WW3), 976(WW3), 977(IR2), 978(AT2), 979(AT2), 980(AT2), 981(IR2), 982(IR2)<sup>c</sup>, 983(HW2), 984(HW2), 985(HW2)<sup>c</sup>, 986(ST3), 987(AT2), 988(CP2), 989(AT2).

JUNE: 990(PO3), 991(PO3), 992(PO3), 993(PO3), 994(PO3), 995(PO3), 996(PO3), 997(PO3), 998(SA3), 999(SA3), 1000(SA3), 1001(SA3), 1002(SA3), 1003(SA3)<sup>c</sup>, 1004(HY3), 1005(HY3), 1006(HY3), 1007(HY3), 1008(HY3), 1009(HY3), 1010(HY3)<sup>c</sup>, 1011(PO3)<sup>c</sup>, 1012(SA3), 1013(SA3), 1014(SA3), 1015(HY3), 1016(SA3), 1017(PO3), 1018(PO3).

JULY: 1019(ST4), 1020(ST4), 1021(ST4), 1022(ST4), 1023(ST4), 1024(ST4)<sup>c</sup>, 1025(SM3), 1026(SM3), 1027(SM3), 1028(SM3)<sup>c</sup>, 1029(EM3), 1030(EM3), 1031(EM3), 1032(EM3), 1033(EM3)<sup>c</sup>.

AUGUST: 1034(HY4), 1035(HY4), 1036(HY4), 1037(HY4), 1038(HY4), 1039(HY4), 1040(HY4), 1041(HY4)<sup>c</sup>, 1042(PO4), 1043(PO4), 1044(PO4), 1045(PO4), 1046(PO4)<sup>c</sup>, 1047(SA4), 1048(SA4)<sup>c</sup>, 1049(SA4), 1050(SA4), 1051(SA4), 1052(HY4), 1053(SA4).

SEPTEMBER: 1054(ST5), 1055(ST5), 1056(ST5), 1057(ST5), 1058(ST5), 1059(WW4), 1060(WW4), 1061(WW4), 1062(WW4), 1063(WW4), 1064(SU2), 1065(SU2), 1066(SU2)<sup>c</sup>, 1067(ST5)<sup>c</sup>, 1068(WW4)<sup>c</sup>, 1069(WW4).

OCTOBER: 1070(EM4), 1071(EM4), 1072(EM4), 1073(EM4), 1074(HW3), 1075(HW3), 1076(HW3), 1077(HY5), 1078(SA5), 1079(SM4), 1080(SM4), 1081(SM4), 1082(HY5), 1083(SA5), 1084(SA5), 1085(SA5), 1086(PO5), 1087(SA5), 1088(SA5), 1089(SA5), 1090(HW3), 1091(EM4)<sup>c</sup>, 1092(HY5)<sup>c</sup>, 1093(HW3)<sup>c</sup>, 1094(PO5)<sup>c</sup>, 1095(SM4)<sup>c</sup>.

NOVEMBER: 1096(ST6), 1097(ST6), 1098(ST6), 1099(ST6), 1100(ST6), 1101(ST6), 1102(IR3), 1103(IR3), 1104(IR3), 1105(IR3), 1106(ST6), 1107(ST6), 1108(ST6), 1109(AT3), 1110(AT3)<sup>c</sup>, 1111(IR3)<sup>c</sup>, 1112(ST6)<sup>c</sup>.

DECEMBER: 1113(HY6), 1114(HY6), 1115(SA6), 1116(SA6), 1117(SU3), 1118(SU3), 1119(WW5), 1120(WW5), 1121(WW5), 1122(WW5), 1123(WW5), 1124(WW5)<sup>c</sup>, 1125(BD1)<sup>c</sup>, 1126(SA6), 1127(SA6), 1128(WW5), 1129(SA6)<sup>c</sup>, 1130(PO6)<sup>c</sup>, 1131(HY6)<sup>c</sup>, 1132(PO6), 1133(PO6), 1134(PO6), 1135(BD1).

## VOLUME 83 (1957)

JANUARY: 1136(CP1), 1137(CP1), 1138(EM1), 1139(EM1), 1140(EM1), 1141(EM1), 1142(SM1), 1143(SM1), 1144(SM1), 1145(SM1), 1146(ST1), 1147(ST1), 1148(ST1), 1149(ST1), 1150(ST1), 1151(ST1), 1152(CP1)<sup>c</sup>, 1153(HW1), 1154(EM1)<sup>c</sup>, 1155(SM1)<sup>c</sup>, 1156(ST1)<sup>c</sup>, 1157(EM1), 1158(EM1), 1159(SM1), 1160(SM1), 1161(SM1).

FEBRUARY: 1162(HY1), 1163(HY1), 1164(HY1), 1165(HY1), 1166(HY1), 1167(HY1), 1168(SA1), 1169(SA1), 1170(SA1), 1171(SA1), 1172(SA1), 1173(SA1), 1174(SA1), 1175(SA1), 1176(SA1), 1177(HY1)<sup>c</sup>, 1178(SA1), 1179(SA1), 1180(SA1), 1181(SA1), 1182(PO1), 1183(PO1), 1184(PO1), 1185(PO1)<sup>c</sup>.

MARCH: 1186(ST2), 1187(ST2), 1188(ST2), 1189(ST2), 1190(ST2), 1191(ST2), 1192(ST2)<sup>c</sup>, 1193(PL1), 1194(PL1), 1195(PL1).

APRIL: 1196(EM2), 1197(HY2), 1198(HY2), 1199(HY2), 1200(HY2), 1201(HY2), 1202(HY2), 1203(SA2), 1204(SM2), 1205(SM2), 1206(SM2), 1207(SM2), 1208(WW1), 1209(WW1), 1210(WW1), 1211(WW1), 1212(EM2), 1213(EM2), 1214(EM2), 1215(PO2), 1216(PO2), 1217(PO2), 1218(SA2), 1219(SA2), 1220(SA2), 1221(SA2), 1222(SA2), 1223(SA2), 1224(SA2), 1225(PO)<sup>c</sup>, 1226(WW1)<sup>c</sup>, 1227(SA2)<sup>c</sup>, 1228(SM2)<sup>c</sup>, 1229(EM2)<sup>c</sup>, 1230(HY2)<sup>c</sup>.

MAY: 1231(ST3), 1232(ST3), 1233(ST3), 1234(ST3), 1235(IR1), 1236(IR1), 1237(WW2), 1238(WW2), 1239(WW2), 1240(WW2), 1241(WW2), 1242(WW2), 1243(WW2), 1244(HW1), 1245(HW1), 1246(HW1), 1247(HW1), 1248(WW2), 1249(HW1), 1250(HW1), 1251(WW2), 1252(WW2), 1253(IR1), 1254(ST3), 1255(ST3), 1256(HW1), 1257(IR1)<sup>c</sup>, 1258(HW1)<sup>c</sup>, 1259(ST3)<sup>c</sup>.

c. Discussion of several papers, grouped by Divisions.

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